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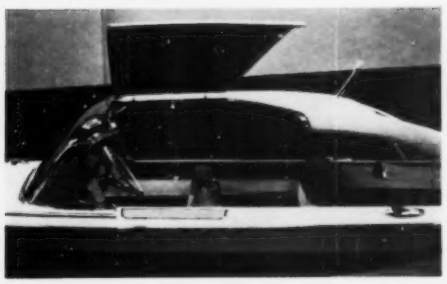
PRODUCT ENGINEERING

McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS · FEBRUARY 6, 1961



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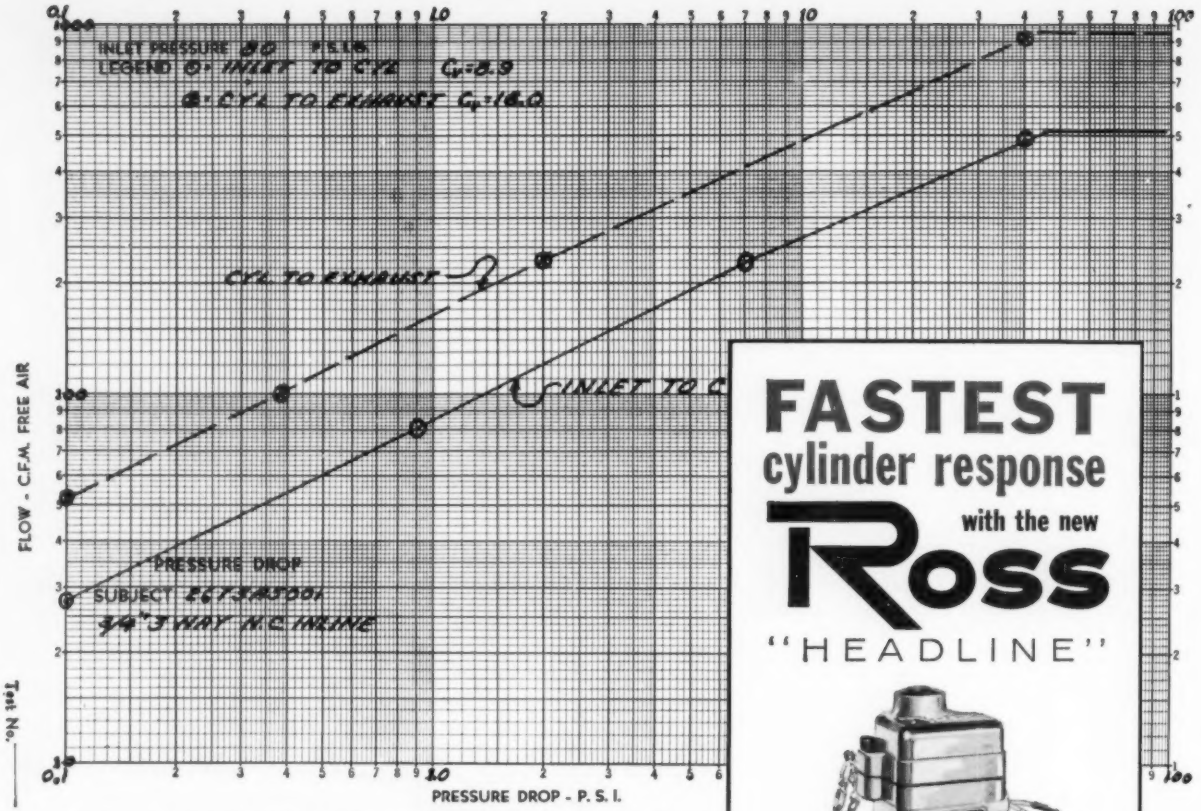
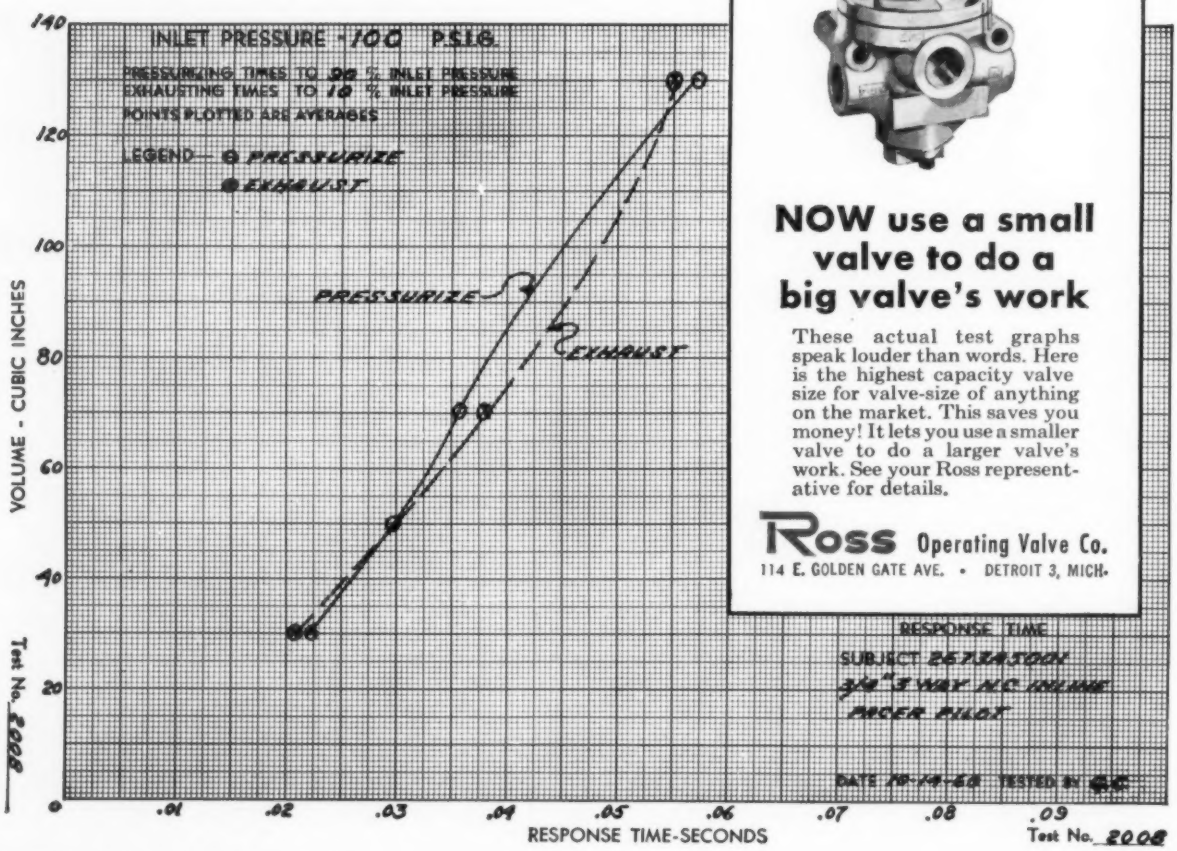

INLET PRESSURE 80 P.S.I.G.
LEGEND ⊙ = INLET TO CYL. C_v=8.9
● = CYL. TO EXHAUST C_v=18.0
CYL. TO EXHAUST
INLET TO C
PRESSURE DROP
SUBJECT 26T3-A100-1
3/4" 3 WAY N.C. INLINE
FLOW - C.F.M. FREE AIR
Test No.
PRESSURE DROP - P. S. I.

These graphs represent one series of tests with a random selected valve under specific conditions of pressure, temperature, humidity, fluid flow and voltage.



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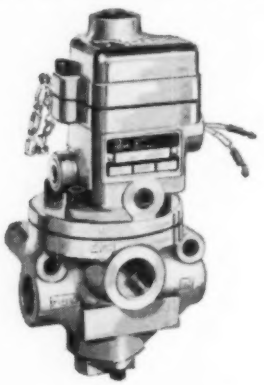
"HEADLINE"



NOW use a small valve to do a big valve's work

These actual test graphs speak louder than words. Here is the highest capacity valve size for valve-size of anything on the market. This saves you money! It lets you use a smaller valve to do a larger valve's work. See your Ross representative for details.

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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY FOR DESIGN ENGINEERS

February 6, 1961 Vol. 32, No. 6

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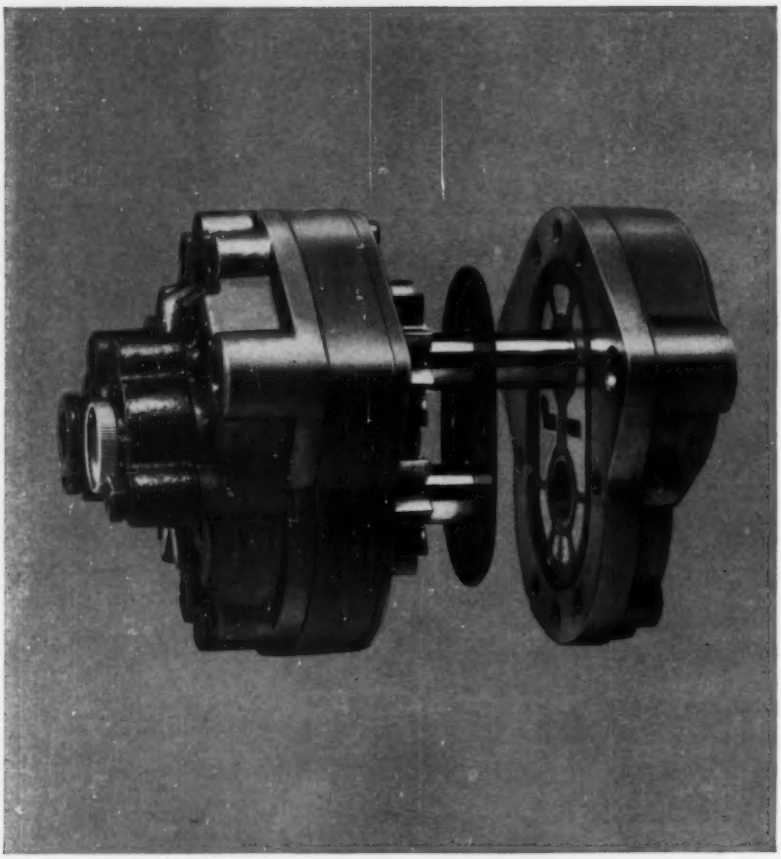
F-M WEAR PLATE "RIDES HERD" ON TURBULENT PRESSURE



IN CESSNA'S NEW HYDRAULIC PUMP LINE, F-M WEAR PLATE DIAPHRAGMS KEEP FLUIDS IN LINE to deliver pressures up to 2000 psi for aircraft, farm and construction equipment, many other hydraulic applications. These wear plate diaphragms maintain positive contact with gears to assure high, uniform pressure. To provide a bearing surface for this job, Federal-Mogul applies a high-density bronze to steel by a special sintering process. F-M high-density bronze prevents fluid absorption, and it affords good lubricity, needed because some hydraulic fluids are poor lubricants. To further prevent the escape of hydraulic fluid, these F-M diaphragms are manufactured for a snug, close-tolerance fit in the pump housing.

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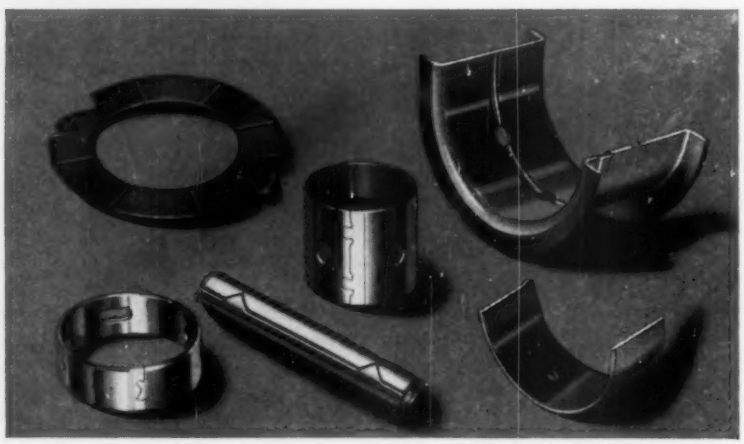

A DESIGN GUIDE provides valuable engineering data for designers on F-M thrust washers as well as wear plates. Also available is literature on sleeve bearings, bushings and spacers. For your copies, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11043 Shoemaker, Detroit 13, Michigan.

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INTERESTING TO NOTE

Latest Train on Record

There was a time when train passengers felt that the purchase of a rail ticket gave them the right to complain about the service, to ask why the company didn't do something about the sudden quake of the dining car just as the coffee was being poured (vibration isolators, p 54, might have helped), or why the 8:03 was never on time. Today, passengers are a little leery about complaining, for fear that tomorrow the railroad may be out of business altogether.

There always have been late trains, but none as late as was Train No. 1 of the Gulf & Interstate (now the Santa Fe) on Sep 8, 1900. At 7 am the train left Beaumont, Texas for Port Bolivar about 100 miles away. As it moved west along the Gulf Coast, heavy winds buffeted the cars. Passengers didn't realize that they were about to witness one of the worst floods in Texas history, a flood that engulfed the city of Galveston, only a few miles away. Weather conditions worsened and about 11 miles from its final destination, the train was swamped by a huge wave, pushed several hundred feet across the tidal marshes and left partly buried in water and sand.

Three years later, having rebuilt its miles of washed-out track, the railroad decided to repair train No 1, still half-buried in sand 11 miles from Port Bolivar. When the train was ready to roll, management offered to honor tickets from the journey that hadn't been completed. Thus it was that Train No. 1 arrived at Port Bolivar at 11:10 on the morning of Sep 24, 1903—three years, 16 days and 10 minutes late.

Test and Tell

"It is naught, it is naught, saith the buyer: but when he is gone his way, then he boasteth."—Proverbs XX, 14.

Never before in our history has the buyer had so many opportunities to spend so much money on so many products. The power of American buying habits has been strong enough to wipe out entire companies one day, create new industries the next. Billions of dollars have been spent just to learn what makes the consumer choose one product rather than another. Certainly one powerful influence is Consumers Union, an independent research

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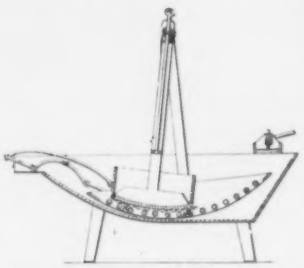
group that spends about $3 million a year evaluating the products put before the American consumer.

Its monthly publication, *Consumer Reports*, circulates about 850,000 copies. The effect of CU's advice can be shown by the recommendation that it gave to one company's dishwasher in 1959. Sales boomed so rapidly that an official of the firm said, "Every morning when I wake up I shake myself, wondering how long it can keep up." In the hi-fi field, a New York retailer claims that after a piece of equipment gets a high rating from CU "sales go up fantastically, and Lord help the ones they say are no good."

One reason for Consumers Union success is its impartiality—its sole income is from subscription and newsstand revenue. Further, it purchases at retail price all products to be tested. The testing philosophy is completely user-oriented; the methods are described on page 56.

For Dirty Duty

For centuries, the housewife devoted at least a full day a week to the ordeal of washing clothes. Her method remained rather constant throughout these many years—press the water-soaked clothes against a hard surface like a board or rock, or else use a push-pull motion against a corrugated surface. In 1846, when an inventor patented a mechanical washing machine, it was only natural that he tried to duplicate the human motion. The rollers and the cradle (see drawing) slid against one another in opposite directions, squeezing the wet clothes between them.



Although this method may have been hard on some fabrics, it worked. In fact, until 1927, Montgomery Ward's catalog carried a similar-type wooden washing machine listed as "our famous Old Faithful." Early wringing machines also tried to duplicate human motions. They consisted of a long sack which the housewife filled with wet clothes. A crank then twisted the sack until most of the water was wrung out. Today, of course, we merely put soiled clothes in a machine (see page 50), push a button, then remove them an hour later, dry and clean.

In World War II, ambitious Pacific-based Sea Bees built their own washing machines out of available components. In general, these were an oil drum fitted with piston and cylinder. The piston was attached to a crude, homemade crankshaft powered by a windmill. Clothes and soap shavings were put in the drum; up-and-down agitation of the piston did a commendable job of getting clothes clean. One of our editors tells us of the time that enemy planes raided a battery of washing machines located on a windy hill. Apparently Japanese intelligence had it that these strange-looking devices were secret weapons being prepared for takeoff.

—Benedict A Leerburger Jr

NEXT WEEK IN PRODUCT ENGINEERING

. . . **Which Decision-making Electrical Control?**

The choice is no longer limited to electro-mechanical devices; you must know about the magnetic and semiconductor types as well.

. . . **Cooling Hot Brakes**

Some brakes must radiate heat away fast; others need time to cool off. Two nomographs give figures you need.

. . . **Feeder Mechanisms—Applications**

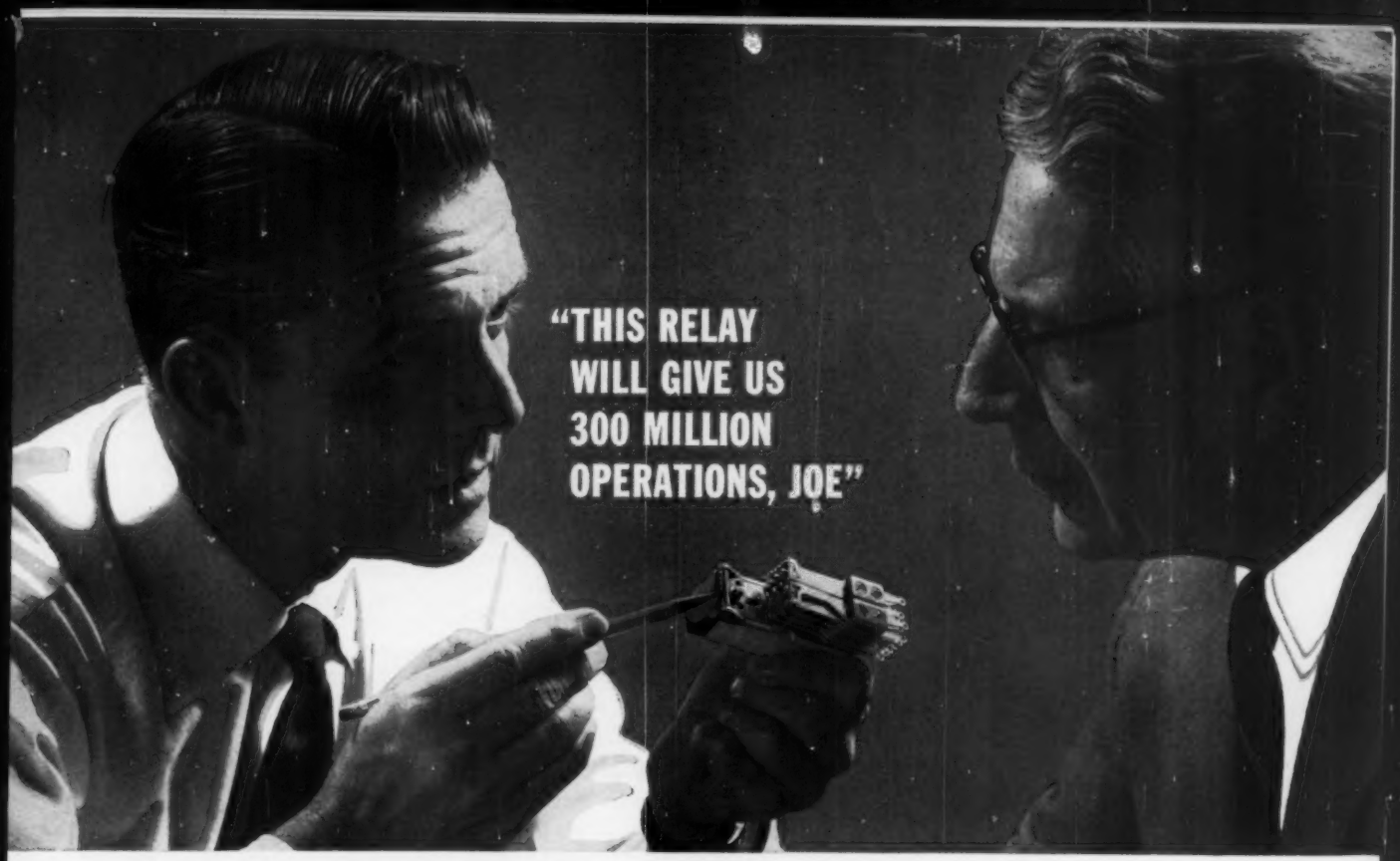
Knowing the basic hoppers, feeders, and conveyors will be helpful in developing new feeder combinations.

. . . **Car Interiors Must be Designed Safer NOW**

Safety authorities say its high time to give passengers genuine protection. Here's what they urge, plus a list of needed design improvements.

. . . **Endurance Diagrams Speed Fatigue Analysis**

An often-overlooked shortcut to an approximate diagram suitable for most ductile steels.



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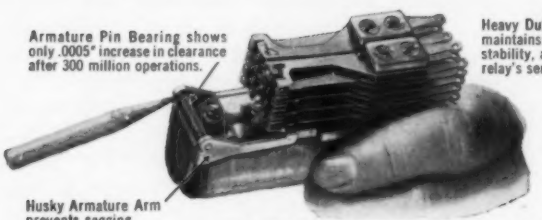
reliable performance over long life


Armature Pin Bearing shows only .0005" increase in clearance after 300 million operations.
Heavy Duty Frame maintains dimensional stability, adds to relay's sensitivity.
Husky Armature Arm prevents sagging or bending.

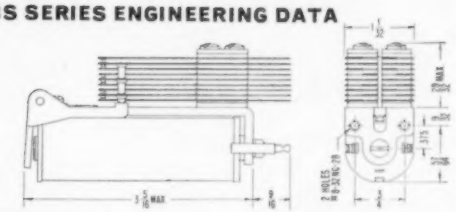
BS SERIES TELEPHONE TYPE

Measure the thickness of the BS series armature arm. You will find the cross section area is greater than ordinary relays of this type. Here is the kind of quality that spells dependability.

Observe that the stainless steel hinge pin runs the full width (not just half) of the armature, providing optimum bearing surface. This pin, operating in a stainless steel sleeve, shows only minimal wear during nearly a *third of a billion operations.*

Best of all, P&B quality costs no more. A whole new plant is being devoted to the production of high performance telephone type relays. Your nearest P&B sales engineer will be happy to discuss your relay problems. Call him today.

BS SERIES ENGINEERING DATA



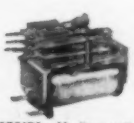
GENERAL:
- **Breakdown Voltage:** 1000 volts rms 60 cy. min. between all elements.
- **Ambient Temperature:** −55° to +85° C. +125° C available on special order.
- **Weight:** 9 to 16 ozs.
- **Terminals:** Pierced solder lugs; Coil: One #16 AWG wire Contacts: Two #18 AWG wires
- **Enclosures:** Dust covered or sealed

CONTACTS:
- **Arrangements:** DC—up to 28 springs AC—up to 24 springs
- **Material:** ⅛" dia. twin palladium. Up to ¼" dia. single silver. Other materials on special order.
- **Load:** 4 amps at 115 volts, 60 cycle resistive
- **Pressure:** 15 grams minimum

COILS:
- **Resistance:** 100,000 ohms maximum Current: 10 amps maximum
- **Power:** DC—50 Milliwatts per movable arm. Greater sensitivity on special order. AC—17.9 volt-amps.
- **Duty:** Continuous
- **Treatment:** Centrifugal impregnation
- **Voltages:** DC—up to 300 volts with series resistor. AC—up to 250 volts, 60 cy.

MOUNTING: Two #8-32 tapped holes ¾" o.c. Other mountings on special order.

GS SERIES—Excellent sensitivity: 50 mw per movable arm minimum (DC). For applications requiring many switching elements in small space.



LS SERIES—Medium coil relay with short springs and light weight armature for fast action, reliability and long life.

TS SERIES—Short coil relay is available in AC and DC versions. Long life construction. Can be supplied (DC) with up to 20 springs (10 per stack).

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WHAT'S HAPPENING IN RESEARCH . . .

More work needed on extruded steels

High-strength, high-temperature steels are still in the developmental stage as far as extruded shapes are concerned, Defense Metals Information Center reports.

An availability survey of hot-work die steels (AISI H-11) and precipitation-hardening stainless extrusions shows they can be obtained on a "commercial" basis, but delivery time is likely to be long, and design freedom limited. Minimum section thickness is often too great for the planned application—calling for excessive machining—and surface quality and straightness leave much to be desired.

Despite these problems, some aircraft manufacturers, at least, believe the extrusions offer better fatigue characteristics than rolled sections, and enough additional advantages to make them worth using even in their present stage of development. Furthermore, current research promises considerable improvement in the relatively near future.

A review of properties and tolerances of materials now available (including low-alloy steels and chrome stainless) has been prepared by DMIC, and will shortly be available through OTS, Dept of Commerce, Washington, DC as PB151097.

Self-checking counter simplifies testing

A counter that checks itself before it goes into operation is helping engineers at Britain's National Engineering Laboratory (East Kilbride, Glasgow).

Except for the special checking circuits, the counter works like any transistorized decimal counter. But it is set up so that the frequency to be counted is supplied to the equipment at one socket, while checking signals of 1000 cycles/sec (count) and 1 cycle/sec (gate) are fed to another.

When operation begins, the 1000-cycle signal is automatically counted for 1 sec. If the count is exactly 1000, and the decimal relay circuits are found to be operating properly, the counter resets itself and checks its zero reading.

When these operations have been performed satisfactorily, the unit proceeds to make the desired count of the unknown frequency. But, if the check is unsatisfactory, the counter simply stops operating until adjustments are made. The complete check takes only 2 sec, NEL says.

A report on the unit and its counting capabilities (it will handle frequencies from 0 to 30,000 cycles/sec and counting periods of 1, 10, or 100 sec) is now in preparation.

Effect of chamfer on bolt strength is charted

Increasing the chamfer of bolt holes markedly increases the shear strength of dowels subjected to shock loads, Naval Research Lab reports.

Tests of SAE 1020 and 1030 dowels show the number of blows the dowel can stand before fracture is nearly 3 times as great for a chamfer of 0.12 in. as for 0.02 in.

The relationship between energy absorbed and chamfer is approximately linear and can be expressed as

$$E_F = E_o + \left(\frac{\Delta E}{\Delta L}\right) L$$

where E_o is the energy necessary to fracture a specimen when the chamfer is zero, and L is the chamfer length. For ¼-in. SAE 1020 dowels, $E_F = 160 + 1952\ L$; for ¼-in. SAE 1030 dowels, it is $205 + 3160\ L$.

A 3-page summary of the study (NRL Problem F01-02) by E. R. Seibert is contained in a Report on NRL Progress (PB161287) available through OTS, Dept of Commerce, Washington 25, DC ($1.25).

briefs . . .

To contain ultrahigh vacuums, Bonn (West Germany) University researchers recommend enameled iron. After testing a variety of glass, metal, and laminated structures, H. L. Eschbach and R. Jaeckel found enameled iron membranes best able to withstand ion bombardment and to prevent penetration by hydrogen gas. Furthermore, they say, it is serviceable at least to 840 F, and shows a low solubility for gas.

Fracture-resistance of acrylic plastic sheeting can be increased by stretch-orientation. But Naval Research Lab points out that heating the material —even to temperatures well below its transition point (200 to 225 F)—destroys advantages of the treatment. Cooling has a similar effect. At 20 F or lower, NRL says, stretch-oriented sheeting is no better than as-cast material. However, when there is a temperature gradient through the material (as in aircraft installations), a good deal of the toughness may be retained. Under such conditions, the stretch-oriented material may still show as much as a 2-to-1 margin over as-cast material at outside temperatures down to 0 F. Photographic copies of the NRL report (PB 149,-850) can be obtained from the Library of Congress.

Electromagnetic sensing instruments, and infrared, ultraviolet, and optical sighting devices, are being developed under Advanced Research Projects Agency sponsorship. The aim: Improved tracking of missiles and means for discriminating between real and decoy devices. It's part of the PRESS (Pacific Range Electromagnetic Signature Study) project, which also includes development of a very high-resolution, long-range (over 2000 mi) radar system. Gen. A. W. Betts, director of ARPA, says the new system will overcome many of the limitations of present ship-borne and airborne systems and provide more information about missiles themselves.

Unexpected problem in operation of organic-moderated nuclear reactors is the fouling and partial plugging of fuel channels. This type of reactor, with its relatively low cost and freedom from corrosion, has been labeled one of the most promising approaches to economical production of nuclear power (*PE*—Apr 14 '58, p 52). The outlook is still good. AEC's Div of Reactor Development says tests have identified the cause of the trouble and methods are being developed to prevent its recurrence. —ARG

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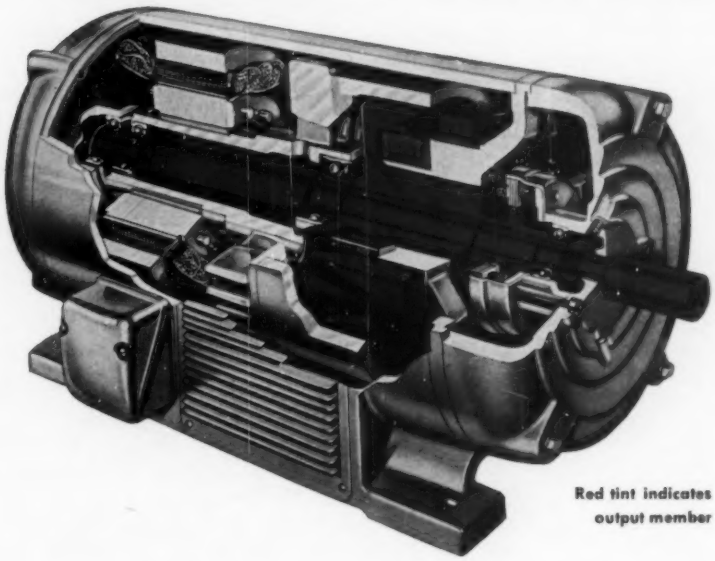

Red tint indicates output member

Extends Capacity Range to 15 HP in the Popular Quill-Type Design

The addition of the new model ACM-905 to the famous ACM-903 and ACM-904 lines of Dynamatic Ajusto-Spede Drives makes the desirable features of Dynamatic Quill-Type design available for many new applications.

Dynamatic Ajusto-Spede Drives provide controlled adjustable speed from an AC power source. Standard control features include on-off clutch control, infinite speed adjustment, constant speed regulation, and jogging. Any of a variety of special features may be easily and economically added to the standard control.

All Quill-Type models are available with either eddy-current, Dyna-torQ, or fail-safe brakes.

An Ajusto-Spede Drive, a control unit (either electron tube or transistorized magnetic amplifier), and a push-button station comprise a compact, easily installed, low-cost drive package.

Check these Ajusto-Spede® Advantages

- ★ **Infinitely adjustable speed from AC power**
- ★ **Simplified construction**
- ★ **Compact design**
- ★ **Wide speed range**
- ★ **Remote control**
- ★ **Stationary field coils**
- ★ **Excellent performance characteristics**

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DEVELOPMENTS TO WATCH . . .

Sparking tool designed for roughening surfaces

A surface-roughening tool that operates electrically rather than mechanically, and deposits rather than removes metal, is reported by Hungarian journal *Ujitok lapja*.

Tiny electric arcs, generated between the workpiece and a bundle of nickel electrodes, form "bumps" on the work surface by transferring nickel during the sparking process. This, the Hungarians say, provides a receptive surface for metal spraying.

An electromagnet, energized by standard-frequency current, acts on a diaphragm and connecting rod to vibrate the electrode bundle. An air blast (through a hollow tube in the center of the bundle) cools the electrodes, and an adjustment screw, working on the diaphragm, makes it possible to change the amplitude of the vibrations.

New insulating resins for electrical components

Varnishes that produce hard, chemical-resistant coatings with "very high electrical properties" are promised by Food Machinery's Chemicals and Plastics Div. These will be based on the company's diallyl phthalate (Dapon) resins; and, FMC says, they will offer excellent resistance to moisture, weathering, and fungal attack. They can be applied by dipping, and will cure at temperatures as low as 212 F.

Formulations suitable for commercial use on capacitors, resistors, transformers, and other components are now under development, and information on typical compositions may be obtained from FMC.

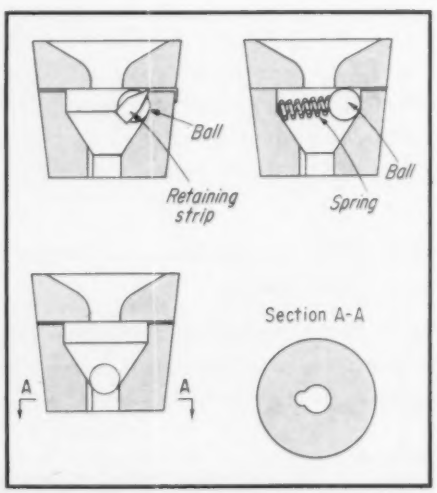
Ferrite switch is fast and powerful

Ferrite rods, driven by a 10-amp current through a low-inductance coil, provide a novel approach to high-frequency switching. The unit, designed at GE's Electronics Lab, is said to be capable of switching 5-kw peak (50-w average) currents in less than one microsec. E. Stern and R. E. Cole are preparing a report on the device for next week's Solid State Circuits Conference in Philadelphia.

Refractory ball meters vacuum-cast metal

A simple but effective system for restricting the flow of molten metal without using small, easily blocked metering holes has been devised by Aktiebolaget Svenska Kullagerfabriken (SKF, Hofors). The primary aim: to improve quality of vacuum-cast metal by increasing the effective surface area for escape of contained gases. Restricting the flow by using small holes can do this. But they are easily plugged.

In the new Swedish system, a refractory ball and steel spring (or retaining strip) are installed in the pouring nozzle (see diagram). Initially, the retainer holds the ball away from the orifice, allowing a relatively high rate of flow and heating the nozzle to a point where it is hot enough to prevent metal solidification. Simultaneously, the retainer is heated to a point where it melts, allowing the ball to fall into the nozzle opening. This reduces the metal stream to a trickle, but prevents blocking of the passage by freezing.



MELTING RETAINER controls metal flow in this refractory nozzle. Either a steel strip (upper left) or a spring (upper right) may be used. When nozzle is hot, retainer melts, allowing ball to fall down, as at lower left, restricting metal flow to the side passage shown in cross-section.

Dutch diesel works on oil or gas

A 4-stroke diesel engine that not only operates on liquid fuel, but also on a feed primarily of gas has been developed by Kromhout of Amsterdam, Holland.

The engine is started on liquid fuel, with a standard injection system; but can then be switched to a lean gas-air mixture when the normal operating temperature is reached.

Key to success of the new engine, says Kromhout, is a high compression ratio (14:1), use of special hydraulic controls, and an automatic device to control the gas supply during dual-fuel operation.

Two new techniques promise better powder parts

Vibratory compaction has been developed to the point where oxide parts can readily be produced with a density of 90% of the theoretical maximum, says Dr Frank K. Pittman of AEC. In fabricating nuclear fuels, he reports, use of this technique could eliminate the problems of individual-pellet density, control of pellet-to-cladding gap clearance, and the need for extremely close tube tolerances. Furthermore, it would remove limitations on fuel-element length and would greatly simplify inspection problems.

Also very promising (Pittman terms it "one of the most exciting developments") is the coated-particle process in which small grains of oxide or carbide materials are individually coated by gas-decomposition in a fluidized bed system. The result is a miniature fuel element, encased in its own protective envelope, that will prevent chemical attack and, at the same time, prevent escape of fission products. Uranium oxide fuels coated with both alumina and pyrolitic graphite are now under test; and, Pittman says, results are extremely encouraging.

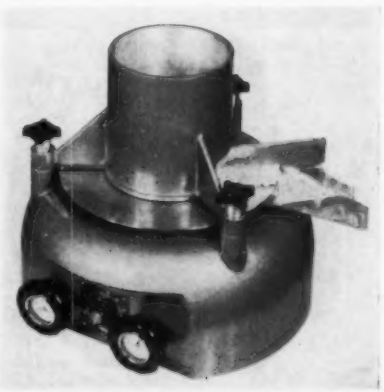
New element heads for heat-resistant alloys

Scandium, the lightweight rare-earth metal already attracting a lot of attention as a possible structural material (*PE*—Apr 25 '60, p 39), may get a new job: as alloying element for heat-resistant alloys. Soviet metallurgists say scandium diboride, produced by powder metallurgy techniques, has a melting point, hardness, and thermal expansion very close to that of chromium diboride, and a density 30% lower. This, they say, (Akademiyo nauk SSSR. *Doklady* v. 133 #6, 1960) "makes scandium diboride a good substitute for chromium as a component of light heat-resistant alloys." Melting point of the scandium compound is about 4000 F; resistivity, 7 to 15 microohm/cm; coefficient of thermal expansion in the 400 to 1500-F range, 9.48 x 10^{-6}.

Constant-rate feeder gets new design

An entirely new principle of operation is claimed for a powder-and-sludge feeder now being introduced in England.

The device has a table rotating beneath a fixed hopper throat. In the throat is an opening on one side of which a blade is hinged so that it projects across the center of the table (see photo). This unit is positioned beneath the feed bin so material falls down the throat, hitting the table and traveling out along the blade, through the aperture, and out over the table edge in controlled amounts.



RATE OF FEED is controlled by angular setting of blade in this British constant-rate unit. Fine adjustments are made by varying speed of table rotation.

Watson-Marlow Air Pump Co., Bŭckinghamshire, the manufacturer, says it is so accurate that "dosing by weight within about 1½% is achieved on a time basis alone." Blade angle, aperture size, and table speed are all adjustable, and the unit is fitted with a timer to stop the table after a preset intervals for batch feeding. Table and blade are stainless. Hopper throat is aluminum, seal is nylon. Initial model is 16½ in. dia at its base, is fitted with a ⅛-hp single-phase or ¼-hp 3-phase fan-cooled motor, and priced at about $900. —ARG

Pumping liquid oxygen for guided-missile fueling at Patrick A.F.B., Florida. Air Products, Inc., a pioneer in the production of LOX and other cryogenic materials, ships liquefied gases in these tank-trailers lined with nickel stainless steel. Piping and supports are also made of nickel stainless steel for high strength at cryogenic temperatures plus low thermal conductivity.

Handling liquid oxygen at 297°F below zero...

. . . Nickel-containing steels retain toughness and strength where other materials become brittle.

These highway tankers haul tonnage quantities of liquid oxygen for missile fueling.

In the nation's steel mills, where vast volumes of oxygen are used to speed up steelmaking, liquid oxygen (LOX) is stored in giant tanks right at the mill.

Ever since oxygen was first liquefied, one of the biggest problems has been to develop materials that will store and handle it *safely*.

LOX is handled at −297°F. Even before you reach that point, liquid mercury becomes so hard you can use it for a hammer, and many materials become brittle and shatter like glass when struck.

But today alloys are available—nickel stainless and other nickel steels—to provide the properties needed for low-temperature work.

Because these steels remain strong and tough at sub-zero temperatures, they are well suited to serve at temperatures where other metals embrittle and fracture. In short, they offer the most economical—and the safest—means to build anything from a liquid-helium generator to an ocean-going tanker for shipping liquefied gases.

If you are active in low-temperature chemistry or physics . . . or if you store or transport liquefied gases in small or large quantities . . . there is exactly the right nickel alloy steel to help you solve your problems.

For comprehensive data on steels for sub-zero service, we invite you to write for a copy of the new booklet, "Steels for the Containment of Liquefied Gas Cargoes." It's yours for the asking.

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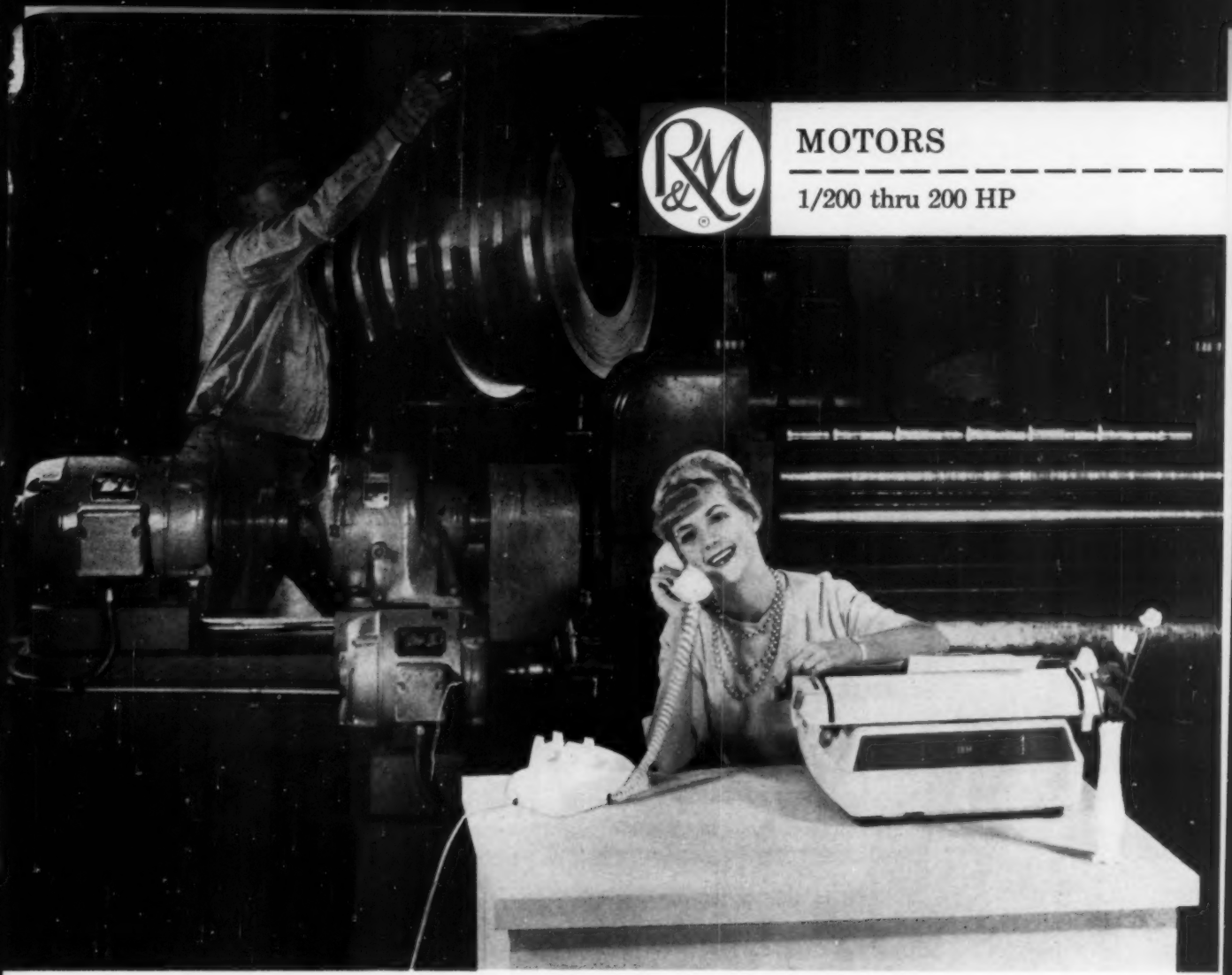

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FROM WASHINGTON . . .

Polaris to ride surface vessels too

The submariner's proved new missile weapon has found a new customer. Navy officially won't admit it, but the decision has been made to put eight Polaris missiles on the nuclear-powered cruiser Long Beach, due for completion late this summer.

Actual installation of the missiles won't come for another year or more, however. Presumably, Navy is waiting until the long-range Polaris missiles, A-2 or A-3, are developed. They will have a range of 1500 and 2500 miles respectively. The current A-1 Polaris is limited to 1200 miles.

Other surface ships may get Polaris too. Some top Navy brass want to put these missiles on conventionally powered cruisers and even aircraft carriers. The missile system, they argue, can be installed on carriers without interfering with plane operation and will give the vessels that much more offensive power.

A plan is underfoot, too, to outfit merchant-type NATO vessels with the Polaris. Full agreement has not been reached as yet, however. The advocates of Polaris argue that these merchant vessels have convenient space available aboard them where banks of Polaris missiles could easily be installed without major structural changes.

AT&T gets okay on communication satellite

The go-ahead to develop a commercial satellite-communication system has been granted by the FCC to American Telephone and Telegraph Company. The federal agency has assigned experimental microwave frequencies for the system. AT&T plans to launch its first satellite within a year. A total of six may be put into orbit by the company during the experimental phase of its program.

Putting each experimental satellite into a 2200-mi-high orbit will cost an estimated $3 million, with the cost of building the satellite put at $250,000. The company will probably launch three of the satellites during fiscal year 1962. In its budget, NASA listed a $10-million contribution from industry for the active communication-satellite program. Unconfirmed reports are that this amount will come from AT&T to pay for launching its test satellites.

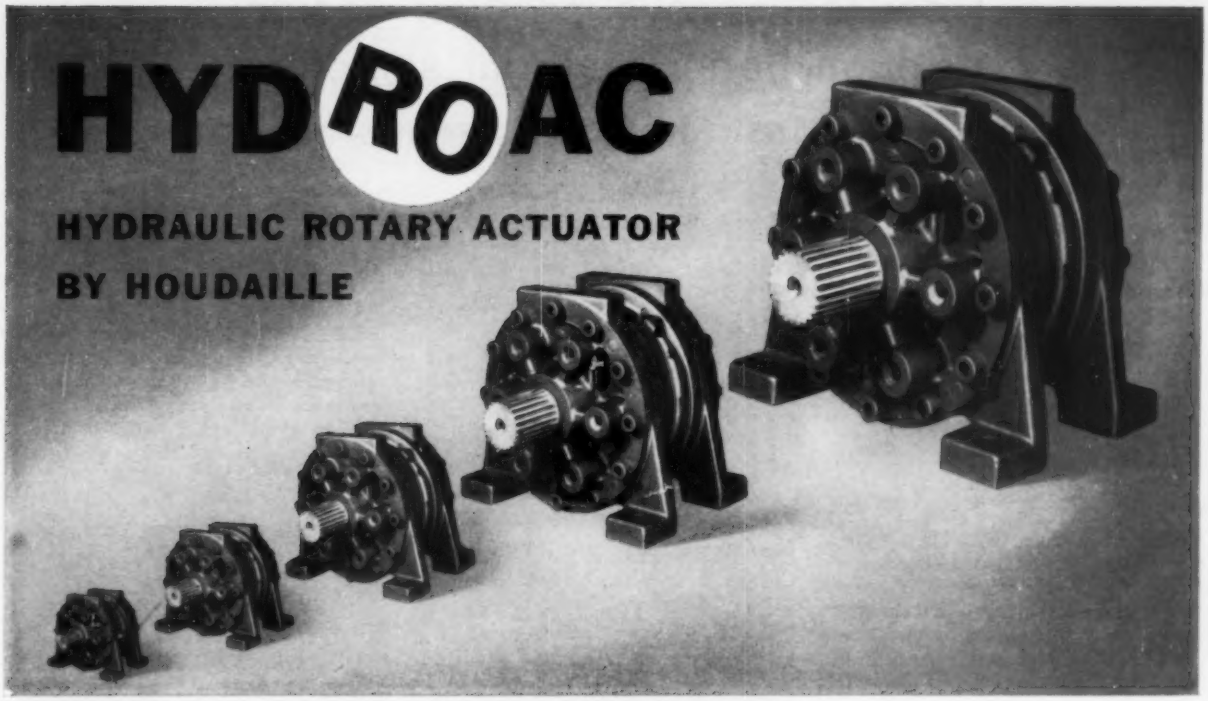
Space programs stir controversy anew

The battle over who does what in space will get hotter soon. The issue was the subject of a special committee report to Pres Kennedy early in January. It blasted the conflict within the military services over space programs, singling out the National Aeronautics and Space Administration for keeping too much in-house research.

Now the House Committee on Science and Astronautics has come up with a report on booster development. It severely criticizes confusion between NASA and the military over booster-development programs, specifically singling out duplication in material studies by the two groups.

Pressure groups within the Air Force and certain segments of industry are trying to reduce NASA's role in space development, the House report charges, and, it blames the situation on the lack of strong leadership for the nation's space program.

An Air Force report on space development is still to come. **It is being prepared by many of the same people who wrote the special report for Pres Kennedy, including Dr Jerome B. Wiesner, now the President's science advisor.** The report is said by some to show that the Air Force should have a larger role in space developments. And, undoubtedly, it will be used by that service to strengthen its position in the field.



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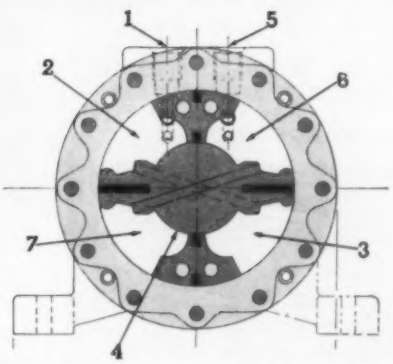
Each size, from the "Tiny" 4.75″ diameter HydRoAc unit to the "Giant" 20″ diameter unit, can be supplied in two lengths, in single and double-vane configuration, and with three different types of bearings. Provision is made for foot or end mounting.

The most effective way to convert hydraulic power into rotary motion, Houdaille HydRoAc units achieve an efficiency of 95 per cent or over. They provide torque from 1500 inch-pounds to 741,000 inch-pounds at 3000 p.s.i., and the operating pressure range extends down to 250 p.s.i. Angular travel is up to 280° for a single-vane unit.



Here's how HydRoAc works

When high pressure fluid enters the port (1) connected to chamber (2), it will cause this chamber, and chamber (3) which is connected by internal porting, to increase in volume. The other pair of chambers, connected to the discharge port, will reduce in volume. This rotates the wingshaft (4) in a counterclockwise direction. Snubbing occurs at the ends of angular travel as the rotating wingshaft vane closes off the discharge port (5) and traps a small amount of fluid in chambers (6) and (7). Rotation in the opposite direction is obtained by reversing hydraulic pressure. Full speed response from the snubbed position is obtained through a check valve.

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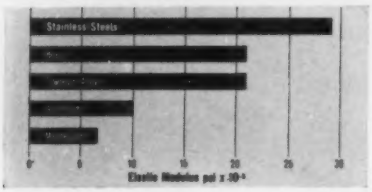
How to improve product design through better material selection

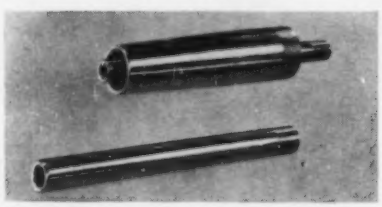
This advertisement is one of a series on the advantages of Carpenter Stainless Steel. As a handy reference for material selection, these data can pave the way for successful results on your next assignment.

Higher elastic modulus



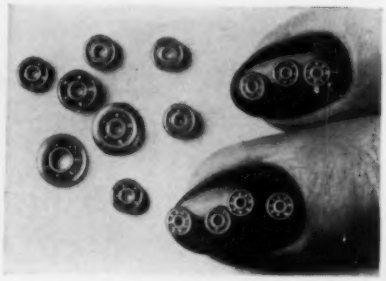
The elastic modulus of an alloy is one of the most important properties used in the design of springs, fasteners, diaphragms and many other components subject to stress in service. Materials with a high modulus deform very little under load; materials with a low modulus may be completely unsatisfactory because of excessive dimensional change. Stainless steels with a modulus of about 29 million psi., are ideal for use in such structural components particularly when either corrosion or heat resistance is also needed. The chart above shows the elastic modulus of materials sometimes considered for such applications.

Better corrosion resistance



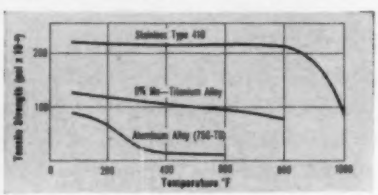
A good example of Carpenter Stainless resistance to corrosion. The nozzles used to fill storage batteries with electrolyte were formerly made from hard rubber. These rubber nozzles did not corrode, but they broke frequently, and proved costly to replace. After switching to Carpenter Stainless No. 20Cb, all problems were solved. No breakage . . . no corrosion . . . more production per shift. The perfect choice of material for this highly corrosive application.

Increased productivity



Big results in miniature . . . with Carpenter Mel-Trol® Stainless No. 440-C. Ten of these miniature precision bearings laid side by side measure only one inch in length! A miracle in close tolerance machining was required to fabricate the race and ball retainers for these bearings. Since a change to Carpenter Mel-Trol No. 440-C, this manufacturer has realized a 200% increase in production. A big improvement for a small item.

Elevated temperature properties



Much of the newer industrial and military equipment is being designed for service at temperatures higher than ambient but not high enough to justify the use of the special high temperature alloys, for example, the maximum operating temperatures of 400 to 800°F. Alloys other than stainless steels have been considered for such applications but from both an economic standpoint and the stress requirements, one of the stainless steels is usually found to be the best selection as indicated in the chart above.

Application engineering service

To help improve stainless steel performance on almost every application, Carpenter has placed in the field this extra service for all its customers. Armed with skill and technical know-how, each Carpenter Representative is available for ideas and suggestions to improve the products you are contemplating. His vast knowledge of new products, plus application guidance and practical assistance can be of great help to you. Get in touch with the Carpenter Representative nearest you. You'll find him a good man to have on your team.

Additional help

Space does not permit a complete listing of description and application suggestions for all grades of Carpenter Stainless Steels. For detailed information on all grades of Carpenter Stainless, write today for the Technical Data Sheets available upon request.

Are you getting all these performance characteristics in the materials you specify?

- ☐ *brilliant finish*
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- ☐ *ease of fabrication*
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Carpenter Stainless gives you *all* these . . . and more!

Carpenter steel

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Alloy Tube Division, Union, N. J.
Webb Wire Division, New Brunswick, N. J.
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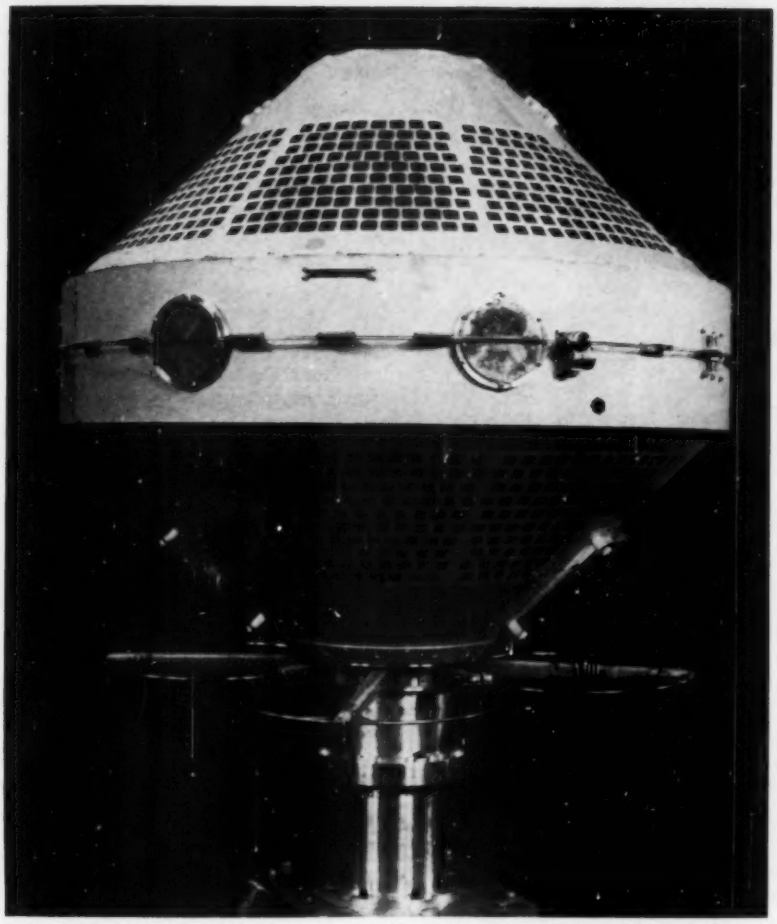


RED AND SILVER PAINTS cover exterior surface of earth satellite Explorer VIII, are one of several thermal control measures adopted at the George C. Marshall Space Flight Center. Above, the dark squares are red paint (silicone and ferrous oxide); silver paint covers remainder of the surface.

New Satellite Paint Cuts Interior Temperatures During Orbit

HUNTSVILLE, ALA—Application of exterior protective paints to the latest Explorer earth satellite has helped reduce its interior temperatures by an estimated 45 deg F, according to NASA scientists here at George C. Marshall Space Flight Center, Redstone Arsenal.

Launched Nov 3 and operating under the thermal extremes of space, Explorer VIII has been successful in gathering basic data concerning the ionosphere.

The exterior paints, red and silver, were one of several thermal control measures adopted by Marshall Center engineers to limit temperature of the satellite's instrument pack and mercury batteries to a range of 32 to 122 F. In addition, the satellite surface had to be electrically conductive, minimizing influence of the ionosphere and permitting that effect to be recorded more easily.

An air-dry silicone paint pigmented with red iron oxide was selected from among all the paints suitable for temperature control, because it is outstandingly resistive to ionospheric environment—particularly ultraviolet radiation. Guided by a templet, the insulative paint was spray-applied to the upper and lower truncated cones in 1388 half-inch squares comprising two 7½-inch bands—an arrangement having the least effect on the electrical conductivity of the satellite surface.

The electrically conductive silver paint was applied in strips above and below both red-paint bands and in two patches on the satellite center section, or equator. Spray-applied with masking techniques, the silver paint covered an area of 610 sq in.

Several factors influenced selection of this paint combination. If the silver paint, which is not as effective for thermal control as the red, had been used exclusively, a larger area would have required the protective coloring. Marshall Center scientists wanted to use as little paint as possible. Also, exclusive use of the red would have interfered to a greater degree with the electrical conductivity of the exterior surface.

NO PAINT ON SENSORS

Some 38% of Explorer VIII's sandblasted aluminum surface was painted. To reduce possible effects on the eight experiments conducted through the orbiter, the paint was kept a minimum of 3 in. from the centerpoint of each of the numerous sensors installed on the exterior surface. The outer shell was constructed of aluminum—rather than fiberglass, as with the Explorer VII—primarily because the metal would permit the accumulation and measurement of static electricity while the 90-lb satellite orbits.

Thermal control of the orbiter was the responsibility of Gerhard Heller, deputy director of the Research Projects Div, although physicist William C. Snoddy, assigned as project engineer, determined what control was necessary and the methods to be employed. In selecting paints for Explorer VIII, Snoddy sought the counsel of Gene A. Zerlaut, a chemist in the engineering materials branch of Marshall Center's Structures and Mechanics Div who had worked on the interior thermal-control aspect of the Explorer VII project. Zerlaut led the development of both the red exterior paint used on Explorer VIII and a white paint applied to its interior surface.

The result: All 8 experiments conducted by the satellite performed properly, according to Marshall Center officials. Most of the instrumentation

—furnished by NASA's Goddard Space Flight Center—was designed to measure positive-ion and electron composition of the ionosphere, which begins 50 mi from earth and extends several hundred miles. Measurements taken by the Explorer VIII payload were in the upper layers of that region. At its apogee, or farthest point from earth, the satellite reaches 1423 mi. Its orbital period is 112.74 minutes.

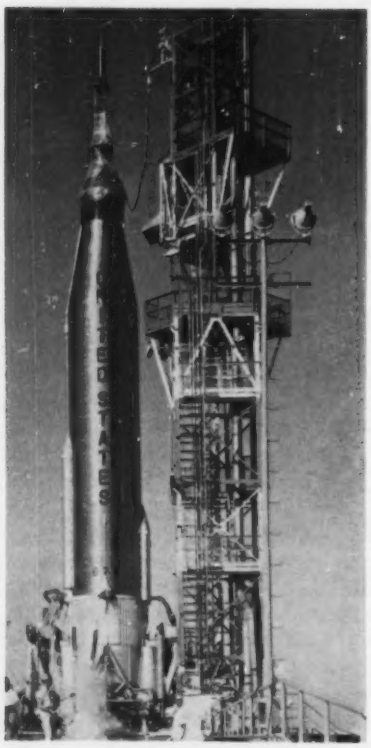
Marshall Center, primarily the developer of large space vehicles for NASA, began operations at Redstone Arsenal last July 1, with Dr Wernher von Braun as director.

—R J Ward
McGraw-Hill World News

Engineers Face Return to Drawing Boards for Cure of Man-in-space Troubles

WASHINGTON—The US man-in-space program hangs in delicate balance which may well force engineers back to the drawing boards and delay the program for many months. The problem: too much bending at the upper section of the big 80-ft tall Atlas ICBM booster chosen to put the one-ton manned capsule into orbit. Specifically, the trouble lies in properly separating the capsule from the Atlas booster.

Though it has worked well for its designed purpose of an intercontinental ballistic missile, Atlas has been plagued with troubles when used for space experiments. The trouble comes when the heavier space payloads are mounted on top of the big booster. Twice, NASA has used the Atlas to test early phases of the Project Mercury man-in-space program. One test was made on Sep 9, 1959, the other on July 29, 1960; both failed to work properly, although test data were obtained.



MERCURY-ATLAS II is readied for test flight at National Aeronautics and Space Administration's Cape Canaveral Atlas launch complex. Black sector toward top of Atlas is the missile's adapter ring.

Engineers on the project now think that the booster is subjected to excessive bending stresses in its programed flight. This prevents the payload from separating properly.

As designed, the Mercury capsule is fitted to the Atlas by an adapter ring, with the capsule bolted to the ring. Small explosives are located in the bolts. At separation time, these explosives ignite to blow the capsule clear of the booster. The separation ring remains on the Atlas booster. The capsule goes on into orbit and the booster eventually drops back into the atmosphere and burns up.

In its two tests, the Mercury capsule separated from the Atlas booster, but not at the proper programed time. This resulted in the capsule's being subjected to much higher G forces and higher temperatures than are considered safe for manned flight.

Engineers on the project have two possible solutions to the problem. One: reprogram the Atlas flight to reduce the stresses exerted on it at separation time; the other, redesign the booster and strengthen it to withstand the higher stresses.

A test of the Atlas-Mercury with a change in programing will come in the next few weeks—the Atlas will be programed into a more gradual flight elevation pattern, with separation of the capsule planned to come earlier than in previous flights.

In its flight path, the Atlas carried the Mercury capsule to an altitude of some 100 mi, then tilts over to a flight path parallel to the earth. The Atlas next accelerates the speed of the capsule to the 17,400-mi orbital speed and separates the capsule. Small peroxide jets on the capsule are fired to reorient it so that the blunt end of the capsule is in the forward position as it orbits the earth.

If proper separation of the Mercury capsule can be accomplished by different programing, then the man-in-space project will move ahead toward orbiting a man around the earth by the end of this year. But, if the programing change doesn't correct the separation problem, engineers will be faced with strengthening the booster. This will take months to accomplish and further delay the program.

—Seth Payne, Regional Editor

Europe May Produce its Own Satellite Launcher

LONDON—British and French governments have invited 10 European countries to a conference in Strasbourg to discuss cooperation among European and UK nations on development of a heavy-satellite launcher.

Invitations were sent to Belgium, Denmark, West Germany, Netherlands, Italy, Norway, Spain, Sweden, Switzerland and Austria.

SEEK SATELLITE LAUNCHER

Object of the conference is to study technical and financial possibilities of collaborating on development of a satellite launcher capable of putting heavy satellites into orbit. Britain's Blue Streak ballistic missile will be used.

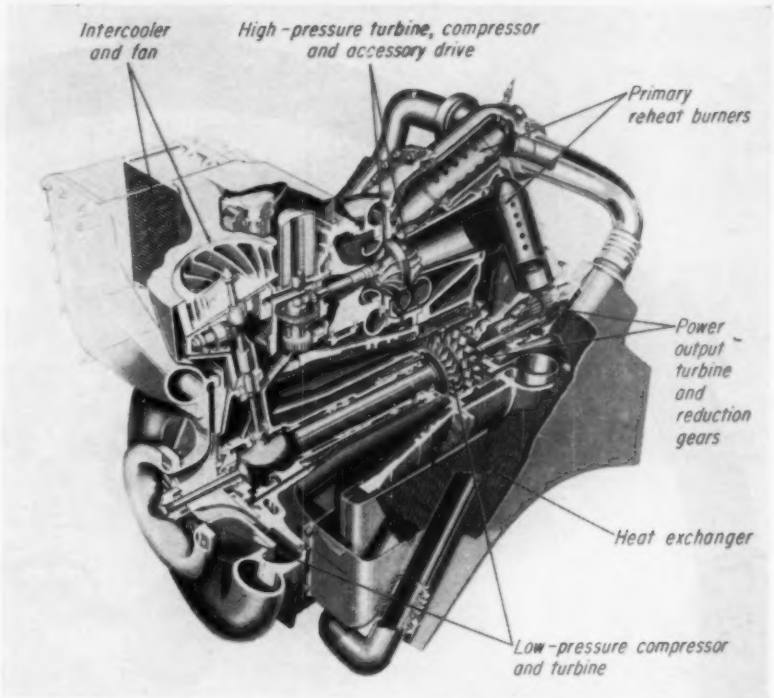
Development of a first series of satellite test vehicles, as a preliminary to possible exploitation of satellites for peaceful uses, will be discussed also.

According to Britain's Ministry of Aviation, the venture would not overlap the planned European space research organization, proposed by scientists of European countries on a technical level.

British Aviation Minister Peter Thorneycroft has already visited with officials of West Germany, Denmark and Norway to discuss the matter informally. ■

Auto Engineers Look Mainly to Materials for Better Designs

DETROIT—The SAE's first International Automotive Congress and Exposition closed on an optimistic note: long-range plans point toward a world whose planes and monorail trains streak across continents in minutes. But the hard-core engineering groups are stuck with mundane problems of improving the vehicles we already have. The result may be substantial advances in the next few years.


Intercooler and fan
High-pressure turbine, compressor and accessory drive
Primary reheat burners
Power output turbine and reduction gears
Heat exchanger
Low-pressure compressor and turbine

EASY ON THE BUDGET: This gas turbine, designed to fit inside the engine compartment of a Ford passenger car, is expected to rival the diesel in fuel economy. Its two compression stages result in over-all pressure ratio of 16:1. Intercooler between compression stages was introduced to cut the work, size and tip speed of high-pressure compressor. Compressed air passes through a reheat burner betwen high-pressure turbine exit and the power turbine.

PROGRESS AREAS

Powerplants: No radically new powerplants such as atomic reactors or fuel cells are expected to reach commercial stages in the near future. Instead, steady improvement of the reciprocating engine is forecast, with most improvements derived from better materials.

Aluminum, the bright promise to the industry a few years ago, has produced mixed results. Chrysler is pushing ahead with an experimental aluminum die-cast engine. But General Motors has run into trouble with its engine and is considering a return to cast iron.

Now magnesium and high-strength ferrous alloys are seen as especially promising. Magnesium is expected to show up in die-cast transmission housings, fuel pumps, and carburetors in 1962 models. The '61 Chevy already has a magnesium fuel pump. Such applications may gain momentum as a result of price cuts for the die-casting alloy. This grade is now selling for about 30¢/lb. According to Dow Chemical, the major producer, price fluctuations from external causes, such as tariff changes, are not likely because magnesium is found in virtually unlimited quantities in the US.

Meanwhile, Studebaker-Packard is investigating a high-strength nickel alloy developed by Inco. With it Studebaker hopes to produce an engine as light as aluminum and with other properties improved.

The only "radical" powerplant nearing commercialization is the gas turbine. One auto company, which declines identification, is scheduling the long-awaited turbine for one of its 1962 models. Meanwhile, signs of underlying activity are plentiful. Wyman-Gordon, a major producer of forged crankshafts, has been shifting staff and facilities to handle an anticipated surge in the gas turbine market. Chrysler has been testing materials for economical production of turbine components. And Ford displayed its 300-hp "704" turbine at the SAE show. It has undergone dynamometer testing for about a year now.

FUEL CELL DEVELOPMENT

Though fuel cells are rife with unsolved problems, Army is pressing their development primarily because they are noiseless. Latest advances reported to SAE was Thompson Ramo Wooldridge's development of a lithium-hydrogen regenerative fuel cell system in which a 63-cell package occupies 632 cu in., delivering 500 watts at 28.35 volts, 17.63 amps.

Body: Present trend is toward corrosion-proof bodies, assembled with adhesives. Corrosion-proofing is a matter of price, and the price is now being brought within practical bounds.

Adhesives for binding structural components are under serious experiment. American Motors is testing a cylinder head made of two diecastings held together by an adhesive. Developed at Minneapolis Mining & Manufacturing, the present adhesives last about 1½ to 2 years. 3-M is working on new formulas.

Tires. For over-the-road track operations, Michelin's wire-cord tires are gaining increasing acceptability. The wire cords, or "belted" tires, are said to improve tread wear, fuel economy, and traction as well as provide a softer, puncture-resistant ride. Present designs are composed of a single ply of wire arranged radially in the tire so that they lie at a 90° angle to direction of truck motion. In textile-cord ply design, fibers normally lie at 37° angle to vehicle motion.

At present, the wire-cord tires do not meet requirements for rough off-the-road terrain. But they have proved out in the Paris subway system (*PE—Jan. 25 '60, p 15*).

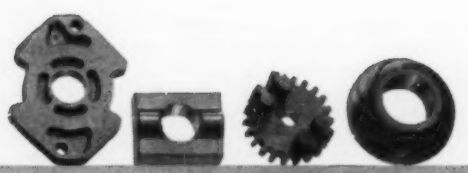
Felix Giordano, Regional Editor

continued on page 20

NEW
MODEL?
NEW
PRODUCT?

NOW'S THE TIME TO EXPLORE NEW SAVINGS WITH DELCO MORAINE SINTERED METAL PARTS

Designing or redesigning a product? Look carefully at components. If they're needed in quantity, Delco Moraine sintered metal parts may offer important advantages in cost, operating efficiency and improved reliability. It may be possible to design a single sintered part to replace a sub-assembly of several parts. Or eliminate the need for expensive machining operations. Or provide a special characteristic to lengthen product life, or improve performance. The controllable porosity of sintered metal parts, for example, permits impregnation with oil for lifetime self-lubrication. Give your new model or product every production break you can. Show components to engineers from Delco Moraine, a leader in the industry for forty years. They know when and how sintered metal parts can best be used. It's to your profit to know, too—and the best time to find out is now, in the planning stage.



DELCO MORAINE

Division of General Motors, Dayton, Ohio

CIRCLE 19 ON READER SERVICE CARD

continued from page 17

Four Subcontractors Team Up for Prime Defense Business

WASHINGTON — Four military-space subcontracting firms have banded together as a single company to bid for government prime contracts under a unique management concept. The four, while retaining separate corporate identities, will act as subcontractors to the new organization—named the United Systems Corp—on any government orders landed by the company.

USC's thinking goes something like this: on most military-space projects in which a prime contractor farms out work to subcontractors, contract costs are pyramided when the prime contractor tacks on his administrative and overhead expenses to the subcontractor's price.

Under USC's plan, the new corporation will earn no profits. Earnings will go to its four member companies in their roles as subcontractors. By eliminating prime-sub costs, the new firm expects to be in an advantageous bidding position for NASA and Defense Dept contracts.

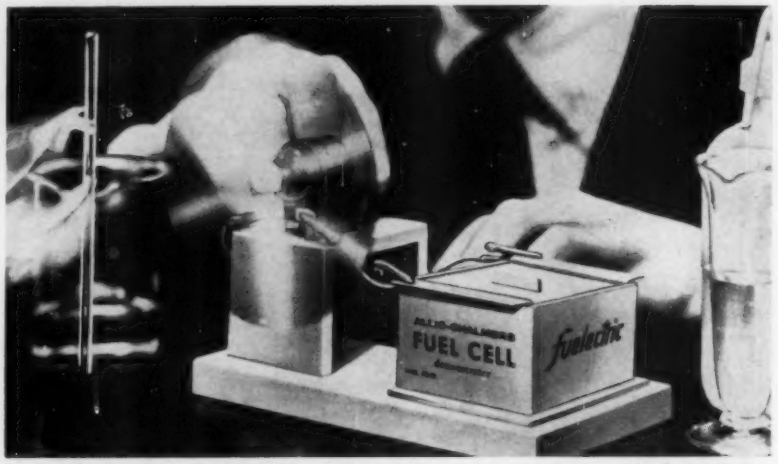
QUARTET OF FIRMS

The four are Amcel Propulsion Inc, a Celanese Corp of America subsidiary specializing in propulsion devices, propellants and explosives; CTL Div of Studebaker-Packard Corp, builders of nosecones, heat shields and heat-resistant structural members; Technology Instrument Corp, specialists in power-transfer systems and electronic instruments and controls; and Merz-Chambers Corp, which builds special machinery, test and ground-equipment support, special tools, structures and assemblies.

Total nonmilitary space sales of the four member companies total about $20 million annually. USC officials estimate their combined capacity can now handle a sales volume of at least $150 million. The new firm plans to make its first bids shortly on contracts for NASA sounding rockets and Army Ordnance assault weapons.

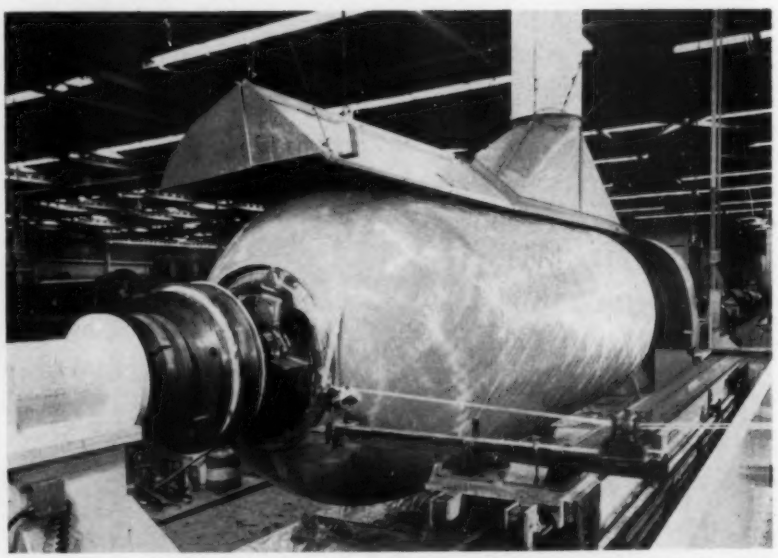
USC's operating headquarters hasn't been selected yet. The new organization will have a small management staff whose costs will be carried proportionately by the four members. **—Mort Reichek, Washington Bureau**

Do-it-yourself Fuel Cell Demonstrator



A working model demonstrator of fuel cell operation is being offered by Allis-Chalmers for instructional and educational purposes. Kit contains a fuel cell (housing and electrode plates) and small motor, plus leads. Easily obtainable chemical ingredients (fuel is alcohol, oxidant is hydrogen peroxide, and electrolyte is potassium or sodium hydroxide) are readily available in highschool chemistry labs. In 1959, A-C displayed the first full-size vehicle powered by self-contained and controlled fuel cells that convert chemical energy to electrical energy. The research vehicle, now in display at the Smithsonian Institution, housed over 1000 individual cells that supplied motive power to a 20-hp motor. Demonstration kits, minus the chemical ingredients, are available for immediate delivery for classroom instruction and educational presentations. Price of the kit is $9.75; shipped postpaid from Allis-Chalmers, Milwaukee 1.

Helical-filament Winder Spins Out a Fuel Tank



A Boeing-developed helical-filament winding machine forms 180 resin-impregnated fiber-glass threads into a single band which is then wound around a pattern to form a tank. Oven-curing completes the process. Boeing is building these experimental 2-compartment (one for fuel, the other for fuel oxidizers) rocket fuel tanks, using the filament-wind technique, for Air Research and Development Command. Tanks are lined with special aluminum foil and a plastic sheeting to prevent fuel from dissolving the bonding agent used to adhere the glass fibers. The above tank measures 6 ft dia and 21 ft long and has a capacity of 3100 gal. It will withstand pressure of 655 psi. Chief advantage of fiberglass tanks over sheet metal is said to be lower fabrication costs resulting from lighter weight. Filament-winding techniques are being applied to making rocket booster cases, pipes, rocket nozzles and radomes.

a designer looks at the Boat Show....

JOHN DAVID BEINERT, *Industrial designer, NYC*

NEW YORK—The sport of boating added in 1960 some $2½billions to the gross national product and untold millions in services and taxes. A large number of engineers, designers, and naval architects are making a major contribution to this industry's products. Yet boating can boast a minimum of professional practitioners. Even most suppliers of goods and services do not get great riches from the sport. They try, but some basically nice idiocy prevents them from achieving this goal. So, with this in mind, I must temper the following remarks about the New York Motor Boat Show, which is the public kickoff for new models and hitherto unexposed new ideas. Let's see what we have for 1961:

Glass-reinforced polyester continues to make definite inroads into conventional materials. This is particularly true in the lower priced planing hull, but also became significant in larger inboard cruisers and, more particularly, in the most tradition-ridden part of the sport, the sailboat. The material, when well used is not necessarily less expensive to fabricate, but is a challenge and an opportunity to both the naval architect and industrial designer. Not too many years ago, when I started designing boats in this material, techniques then in use precluded some of the manufacturing tricks demonstrated this year.

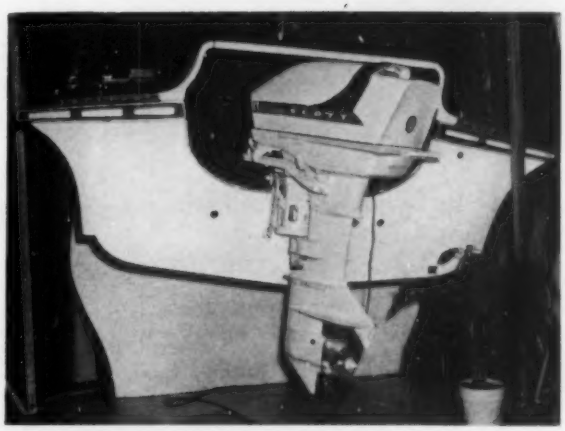
Most of the types of motorboats exhibited suffered from excessive chrome and aluminum, and a slavish devotion to automobile design. The latter even extends into design areas that can decrease safety and hazard limb and hull. We can only hope that boat designers will return to first principles and, with respect for the uncompromising sea, begin to abandon auto design and work on sounder principles to achieve a design theme unique to boats in new materials. At least, this year the fin is almost a thing of the past.

Perhaps part of the problem is the excessive stress on speed. With outboard motors available up to 80 hp and lightweight inboards of vastly greater power, the industry has tended to feature speed rather than safety. In outboards particularly this has been true. Outboard Boating Club has used a completely unrealistic formula for computing the horsepower-carrying characteristics of given hull dimensions. Dealers of course, sell what brings the most profit. I don't mean that the industry is necessarily venal, but more and more laws and taxes are being enacted because of the accident rate attributable to excessive speeds.

Most of the outboard motors perform well, but they hardly resemble anything like the old jobs we once knew. Now you can get them with everything hooked on that you would find in an inboard—and they go one better in that even a bailing pump can now be attached as an accessory. Housings for many of the outboards are fiberglass-reinforced plastic.

With greater horsepower comes greater weight in outboards, and in the high-hp range this can run to over 250 lb. Add to this gasoline tanks, batteries, heavier and stronger transoms to support the load, and any other accessories required, and you have a design problem. One way of overcoming this is the latest combination called the "inboard-outboard." The Winner Co boat shown on page 25 illustrates this configuration; the economies are obvious. Inboards will work at a considerably lower rpm to achieve the same thrust, thus increasing engine

text continued, page 24



FOR SAFETY, self-bailing wells should extend at least 30 in. forward from the stern—the one in top photo merely makes the gesture. Transom cutouts that retain too little freeboard are also hazardous; the one in bottom photo leaves only 15 in. from cutout to underside of the boat.

THIS AUTOGIRO actually works, apparently. Without motor of its own, forward motion it needs to become airborne must be provided by towline and a fast boat.

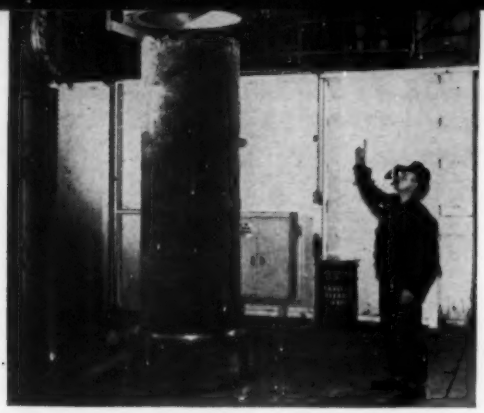
REPUBLIC HIGH-PERFORMANCE METALS FOR THE HU2K

Scheduled for fleet delivery in 1961, the all-weather Kaman HU2K "SEASPRITE" was developed to meet *high-performance* requirements of the U. S. Navy. Working closely with Kaman design engineers, Republic Steel is supplying light gage titanium and stainless steel for the HU2K.

Selected for its resistance to corrosion and abrasion, stainless is used in leading edges of the rotor blades. The titanium—Type RS140—is used in 1½″ x 18″ strips. Assembled in bundles of 88, these strips are machined into retention straps that are a vital component in the rotor system.

May we help you utilize *high-performance* metals in your project? Republic is the nation's largest producer of alloy and stainless steels, and a major producer of titanium. Republic has the most *extensive vacuum-melting facilities* ever assembled. For complete details, contact your Republic representative or mail the coupon.

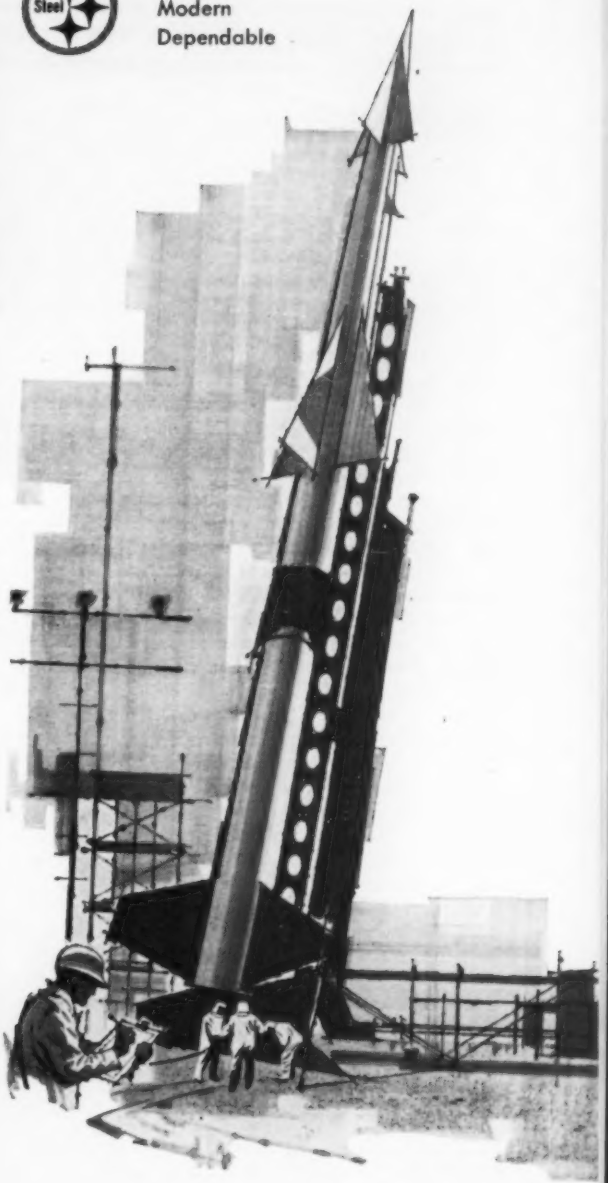
CIRCLE 22 ON READER SERVICE CARD

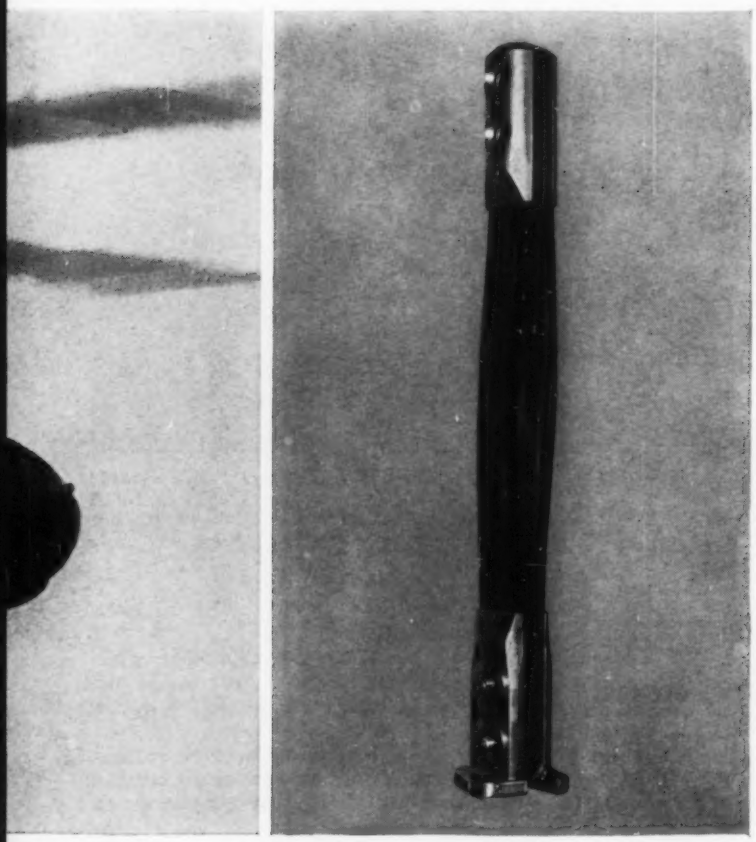


REPUBLIC VACUUM-MELTED METALS are produced in 18- to 32-inch diameter ingots weighing from 4,000 to 20,000 pounds. Vacuum-melted super alloy steels, constructional alloy steels, high strength alloy steels, bearing steels, stainless steels, titanium, and special carbon steels are available from Republic in plates, billets, bars, sheets, strip, and wire. Mail coupon for complete information.

3-DIMENSIONAL METALLURGICAL TEAMS: Republic's mill, field, and laboratory metallurgists and machining experts help you select and apply the metal best suited to requirements. Mail coupon for details on this confidential, obligation-free service.

Strong
Modern
Dependable





BUNDLED TITANIUM RETENTION STRAPS are designed to work through a torsion angle of ±13°. Each strap provides a minimum tensile strength of 155,000 psi. The HU2K "SEASPRITE" is manufactured by the Kaman Aircraft Corporation, Bloomfield, Connecticut.

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Name_____ Title_____
Company_____
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Boat Show....

life. They are somewhat more accessible and, best of all, the movement inboard brings the weight closer to where it should be. An inboard will also provide greater safety since the transom need not be cut back to fit the lower-setting outboard. Do we lose cockpit space with these? Not especially, because hulls for the bigger outboards use devices called a self-bailing well to catch any slops from astern. To be truly effective, the well must extend at least 30 in. from stern forward.

Designers of large motor cruisers have evidently learned that the general appearance of the boat must be one of massiveness and that the interior decor must appeal to women. Without it you don't sell boats. So the interior cabin spaces resemble a fancy motel room. Wall-to-wall carpeting is a must. All seating units convert into berths unless the hull is large enough to have sleeping cabins. Fancy table lamps abound. Tiled shower rooms just like home, air-conditioning units, tel vision sets and exotic wood finishes complete the illusion.

The exterior is equally luxurious. Heavy, chrome-plated castings, two or three colors splashed over the hull and topsides, split-level steering control. You can also have a flying bridge, bow pulpits, inefficient—but polished—life rails. There is chrome on practically everything that can be plated.

The hulls of these big cruisers are generally of the planing type. While this kind of hull can be driven at higher speeds then displacement types, economy, comfort and performance fall off at lower, non-planing speeds. And as our waterways become more and more crowded with this type of boat, local authorities are replacing speed-restriction signs with those that read "Leave no wake". What price speed?

Perhaps the greatest influences on sailing yacht design have been the lessons learned from aerodynamics. Good designers have used every device to clean up excrescences to reduce windage and drag, materials research has led to lighter-weight fittings, aluminum has contributed strong, light spars and even hulls. Sails are now almost entirely made from synthetic fibers such as Dacron. They set better and last longer than cotton.

Perhaps in no other industry have synthetic materials taken over so much—from hulls to seat cushions. Any hull, regardless of material, requires surface refinishing. To satisfy this need, almost all major, and quite a few minor, paint companies offer a wide variety of finishing materials and colors. Acrylic, epoxy and other resin-based paints made their debut about three years ago and have established themselves firmly in the field.

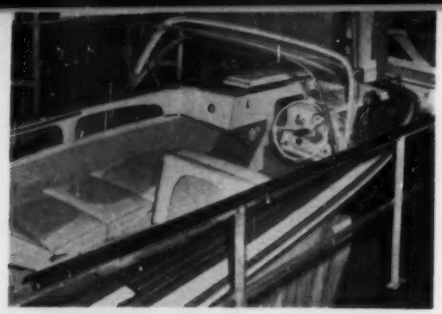
Several brave manufacturers have also begun to make such items as fittings, cleats, chocks, running rigging blocks from phenolics and nylon. The evidence indicates that they work well.

One company has sheeting that simulates a wood deck finish with the seams printed thereon. A contact adhesive is usually used with this kind of material and more often than not comes as part of the sheet. Personal testing has proved that two years of continuous exposure, in all weather conditions, has not destroyed the bond and has had only some slight effect on the surface, mostly in the nature of dulling the gloss finish and some color fading. Resiliency and strength have not deteriorated appreciably.

Trailers for boats have become a substantial part of the boating scene. The boat trailer is still functional and, surprisingly enough, does not attempt to imitate anything done to autos. Wheels they have, and winches, tail lights, rollers and hitches but very little, if any, trim.

Aluminum has been exploited for the last few years in small runabout hulls. Some larger hulls have been clad with the material but in each case some forming dies have been needed or time-consuming planishing operations. The all-aluminum planking technique exhibited by the Richardson Boat Co Inc, has caused a stir. It is possible that it can become a factor in large hull construction.

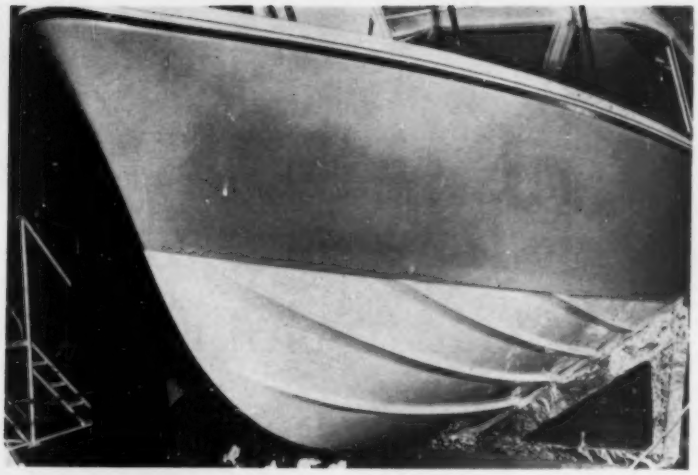
In sum: Some things have been over-designed to the point of idiocy, some things need design attention—to sell better or to work better. Like any other industry, boating is placing more and more reliance on new materials and processes and in consequence some abuse and misapplication will occur, but these will be corrected in time. The sea does not countenance fools for long. ■

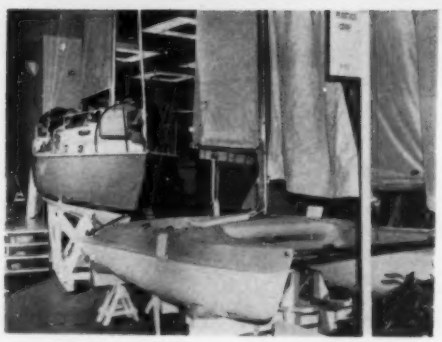


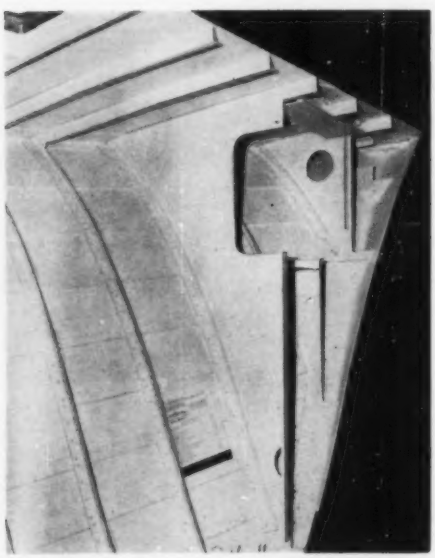
LIKE TO WALK these glittering decks—especially when they're wet? Getting forward on another of the new boats at the show, top, requires cranking back windshield, then opening a deck hatch. Better not be in a hurry!

MOST CONSERVATIVE—yet able—sailing boat design shown was this double-ended sloop built abroad and modified to suit American tastes—its 29-ft length will sleep four.

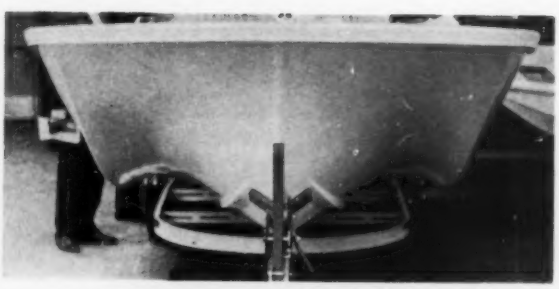
STERN SECTION of Winner Co boat, above, shows how improved fiberglass-resin hand layup and molding techniques have allowed precise treatment of gunwale, small ball corners and clean fillets. Same new methods give the lift and stabilizing longitudinals designed into hull of Bertram inboard, top, right. These keel-like strakes actually induce a planing lift at speeds above 21 mph! The "vees" are packed with glass and resin, molded integrally with rest of the hull. Examples of fiberglass-reinforced hulls for sailing are the catamaran and 30-ft sloop made by Aero Marine Plastics Corp, right.





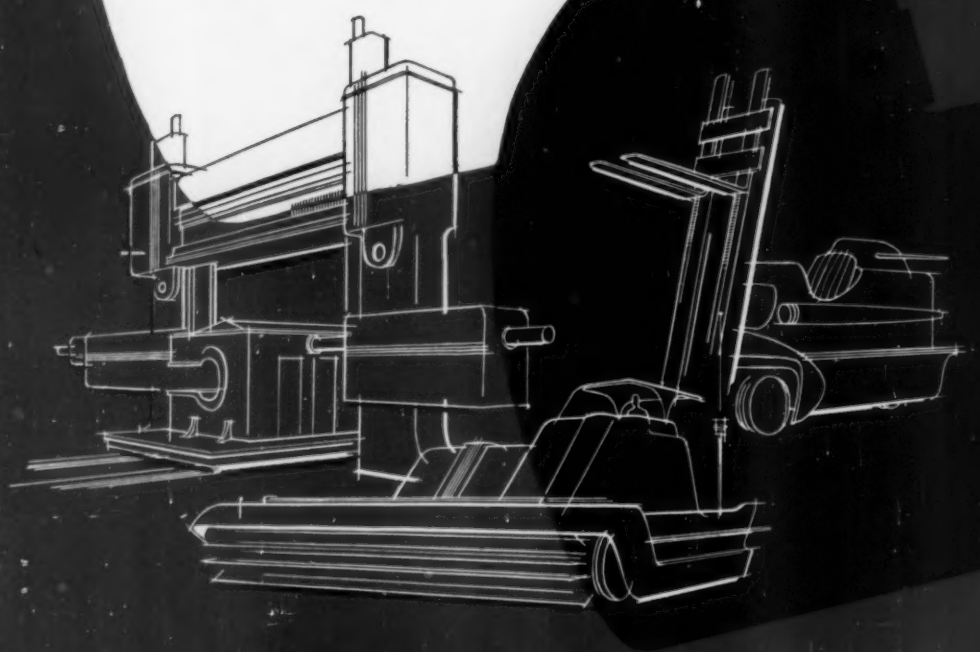


ALUMINUM PLANK HULL made by Richardson simulates a wood hull of the carvel type; basic construction methods are similar, too. Longitudinals of aluminum are attached to the ribs and the planks are riveted thereto with a faying agent between to act as caulking. Rivet heads are then countersunk.



BEST SMALL HULL at the show was the "Boston Whaler's" based on a rectangle and molded of inner and outer fiberglass laminates with urethane foam between. Foam provides flotation factor, also sufficient pressure to force laminates against mold surfaces during manufacture. Hull has been tested for 1000-lb reserve buoyancy, is free of glitter and meaningless decoration.

Whatever
the shape of your future product-
McGill can help you now
with your bearing needs



The shape of things to come may or may not be known to us now, but we can be pretty sure many industrial machines and related equipment will look and operate differently from today's versions — also there will be those products not even existing today. They will put new demands on bearings — in shape, speed, capacity, space saving, accuracy, reliability and simplified product assembly.

All new products must have a beginning — a research and development stage when components must be designed, built and tested in progressively improved prototypes. This is the time to take advantage of McGill engineering experience with thousands of proven applications using needle type roller bearings and cam followers — and special ball and roller bearings to precision specifications. McGill application engineers can help you design in greater bearing efficiency earlier with savings in time and expense. Call them in to work with you and for you — *at the beginning.*

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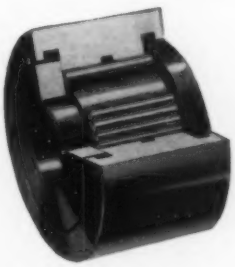
Sealed to keep contamination out and lubricant in. It is dimensionally interchangeable with the CF bearings. A turned groove in the center of the outer raceway bore provides a permanent lubricant reservoir to approach life-time lubrication requirements. Can be easily re-lubricated.



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Write for Catalog No. 52-A for full information on McGill's needle roller bearings, and cam followers. Ask about recommendations for high precision special ball and roller bearings.

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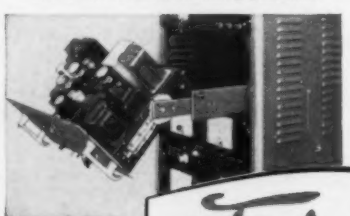
Suppose you want to transfer a piece of equipment from one cabinet or rack to another. Nothing to it with Chassis-Trak. Simply press a push button spring and the entire chassis comes out. Then slip it into another rack equipped with Chassis-Trak Slides and the changeover is complete. Because Chassis-Trak parts are interchangeable (even on different models and sizes), equipment fitted with slides in one work area can be mounted without modification in Chassis-Trak-equipped cabinets *anywhere*.

Chassis-Trak Slides come in nine stock lengths and support loads up to 275 lbs. More than 200 standard models meet every installation need. Approved for military use.

Chassis-Trak "Detent" slide, shown in one of seven different tilting positions.



chassis Trak inc.

For further information contact:

525 South Webster, Indianapolis 19, Indiana

28 CIRCLE 28 ON READER SERVICE CARD

READER TO EDITOR

Improved Area Calculation

To the Editor:

In his "Get More From Your Slide-rule," Nov. 7, '60, p 73, the author describes the folded-scale feature and its recognized advantages, especially when the calculation involves the factor π. The method described on p 74 is not really the most accurate; with the answer terminating on the A or B scale, further calculations continue at reduced accuracy unless answer is reset on another scale.

The CIF scale adapts itself to a simplified method for area calculation as follows: Set the indicator to the radius on the *D* scale and opposite to this set the radius on the CIF scale and read the area on the *D* scale at the index of C scale.

Values on the *D* scale set opposite to values on the CIF scale simultaneously include multiplication by π. Also, the resulting area on the *D* scale facilitates further calculation. —Edwin W Albers
Schenectady, NY

Designtown Revisited

To the Editor:

"The real professional engineer," according to a manager quoted in Designtown, USA (*Dec 26 '60, p. 46*), "is one who comes close to eating, drinking, and sleeping engineering."

Later on, the "dedicated" engineer is defined as a person who is an engineer 24 hours per day, 52 weeks per year. The story reflected some surprise that this represented only about 10% of all engineers. The rest were termed "nondedicated"—using engineering as a "meal-ticket" and fit only for doing "dog work" until they can be replaced by computers.

Perhaps it was significant that no attempt was made to explain why the overwhelming majority of engineers evidently balk at adopting the monolithic existence suggested as the ideal. (Aside from an oblique reference to a lack of early religion-like indoctrination — a frightening thought in some ways.)

And, too, this very ideal may be at the root of the problem C. P. Snow examined in "The Two Cultures"— that scientists (and nonscientists) are too deeply wrapped up in their own particular worlds to be able to communicate with each other. —C W Schuyler
Shawinigan Falls, Que

New Calendar

To the Editor:

The article on a different division of our units of time (Aug 15 '60, p 46) has stuck in my mind and the other day a slightly different approach came to mind.

It's true that 5 is a logical factor to use for a week, since the two prime factors for 365 are 73 and 5. However, 72 weeks divided into 12 equal months would seem quite as usable as 70 weeks divided into 7 equal months, since it is only for the sake of dividing up the rather awkward

365.26 day period of the earth's orbit anyway. Calculations, of course, would still best be worked in decimals of a day with ranges in units available from micro-day (about 86 milliseconds) to kilo-day (about 2¾ yrs.). I believe another letter to the editor recently mentioned this.

At any rate this would give a different picture to the calendar and clock as indicated below:

M	W	F	S	S
1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30

There would be a Tuesday tagged onto tl e last week of every leap year except such years as the astronomers deemed necessary to keep us in step with our earth's orbit period.

If for nothing else, the conversion should be strongly supported to encourage and benefit those who are in the habit of using the expression "I'll pay you next Tuesday." —Max M Aydelott
Director of Research
Southern Pipe Div of USI
Azusa, Calif

CORRECTION

In our issue of Nov 29 '60, on page 3, there appeared the statement: "Until recently, almost all the very fine-mesh wire filters—with nominal ratings down to 15 microns—had to be imported from Germany." For many years, wire cloth has been available in this country as fine as 30 microns. Actually, the first wire cloth with a finer micron rating—down to 18 microns—was woven in the US in 1952 by Unique Wire Weaving Co Inc, Hillside, NJ. Shortly thereafter, the same company produced 10-micron wire. German makers began producing equivalent wire mesh about 1954.—Ed.

COMING EVENTS

FEBRUARY

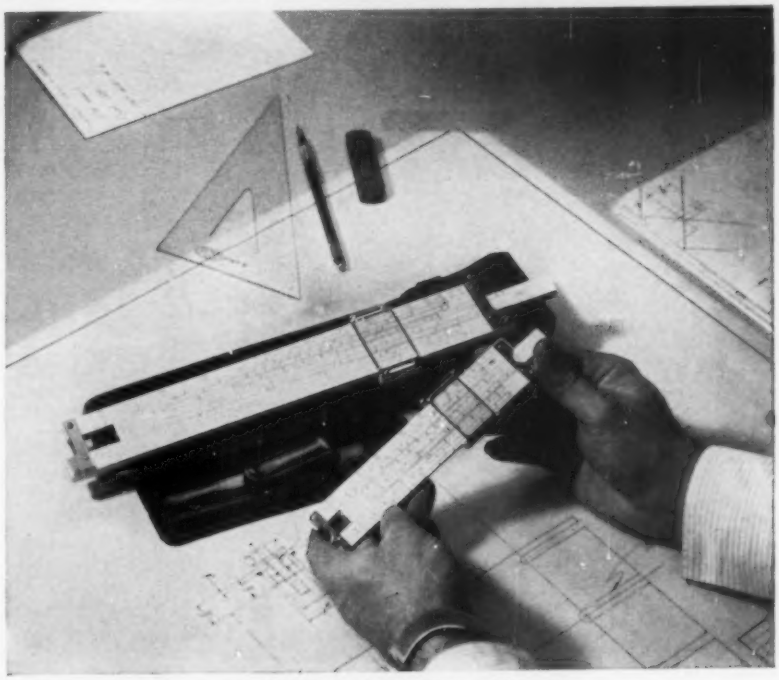
14-16 . . . . Society for Nondestructive Testing & Southwest Research Institute, 2nd Annual Symposium on Nondestructive Testing of Aircraft & Missile Components. Gunter Hotel, San Antonio, Texas

15-16 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, 8th Annual International Solid-State Circuits Conference. Univ of Pennsylvania & Sheraton Hotel, Philadelphia

26-March 2 . . . . American Institute of Mining, Metallurgical & Petroleum Engineers, Chase Park Plaza & Ambassador Hotels, St. Louis

For a current listing of addresses of societies and associations send 25¢ to Product Engineering Reader Service Dept, 330 W 42nd St, NY 36. Ask for brochure, R 32.

DRAFTING TRENDS



This is a size comparison between the 10″ POST Versalog and its 5″ replica, the POST Pocket Versalog.

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That there is a need has since been proved by the thousands of engineers, architects, scientists, and students who have bought and used a Post Pocket Versalog in preference not only to the larger version, but after comparing it with other smaller makes.

As to accuracy, we are still amazed at the exquisite job our production team has done in miniaturization—the 5″ Pocket Versalog includes every one of the 23 scales found on its much larger counterpart and, in addition, bears engine-divided calibrations of such sharpness and clarity that no magnifier is needed.

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To further popularize this fine instrument, Post dealers are offering it at a special low price for a limited time. All models come with a handcrafted leather case and spring pocket clip. Also available with hard-bound instruction text.

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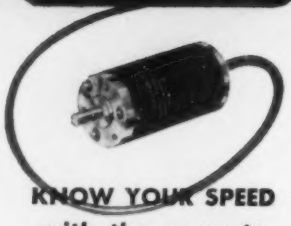

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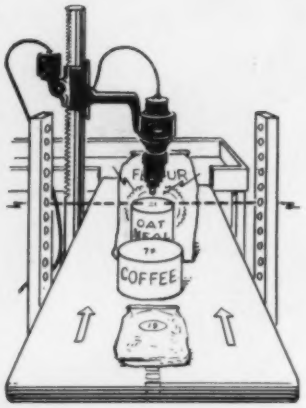

. . . a way of marking grocery items in supermarkets so that your bill would be totaled automatically. Modern supermarkets have adopted a number of gadgets to increase the speed of servicing customers. The most recent innovation: a conveyor that delivers the bag of groceries to your waiting car. But the weakest link in the chain—and the slowest—is the time consumed at the checkout counter. If each item were tagged with a price written in magnetic ink, checkout would be automatic. As the item passed below a pickup head, the price would be read and added to the total. When the last package passed through, the register would indicate total and dispense an item-by-item list along with the proper number of trading stamps. Or perhaps price could be read by an optical scanner or taken from a punched paper tape attached to each item. —B ARNOLD

. . . a heater for automobile windshield-washer fluid. When the car has been standing in a freezing rain, the hot fluid would remove ice and slush from windshield and wiper blade. A small tube wrapped around the exhaust pipe or heat from the cooling water should do the trick. — DEPEW

. . . a remotely controlled, shutter actuator for home movie (and still) cameras. Home movies usually show a fatherless family because Dad is occupied with the camera. If the camera were controlled by an ultrasonic tone from a hand-held resonant fork (similar to remote controls for TV), no one would need to be left out. A resonant reed in the camera would close a latching relay and start the mechanism. Another tone would stop the camera. Or, for longer range work, a small, citizen's-band transmitter and receiver could be designed to do the job. The long-range remote control would also be valuable for bird or animal photography. —R MARIF

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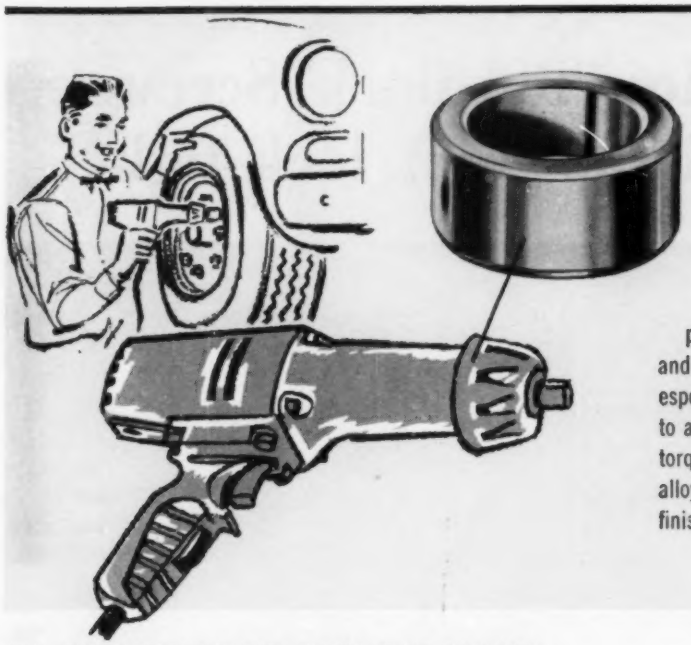

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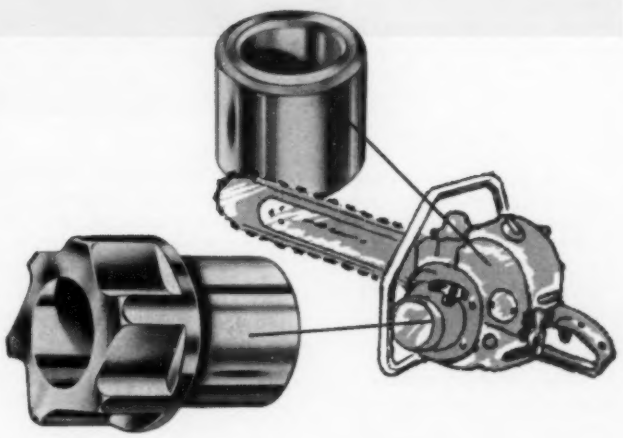

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Technical-ities

By Fred E. Graves

Fastening of joints in corrosive environment

For a fastener to stand up in a corrosive environment it must either be coated, or made from an anti-corrosive metal.

THE METALLIC COATINGS

The "workhorse" applications are satisfied most economically with SAE Grade 2 or Grade 5 fasteners. Required outdoor durability is achieved with a plated or a hot galvanized finish. Hot galvanizing complicates good thread fits, costs more than plating in the popular size range, but gives much greater protection than any commercial plating.

A heavy galvanized coating is not recommended on highly stressed fasteners. If you need the high strength of Grade 5 bolts and want them corrosion-resistant, zinc plating should be your first choice. Certain conditions may require cadmium, nickel or copper plate.

THE ENDURING METALS

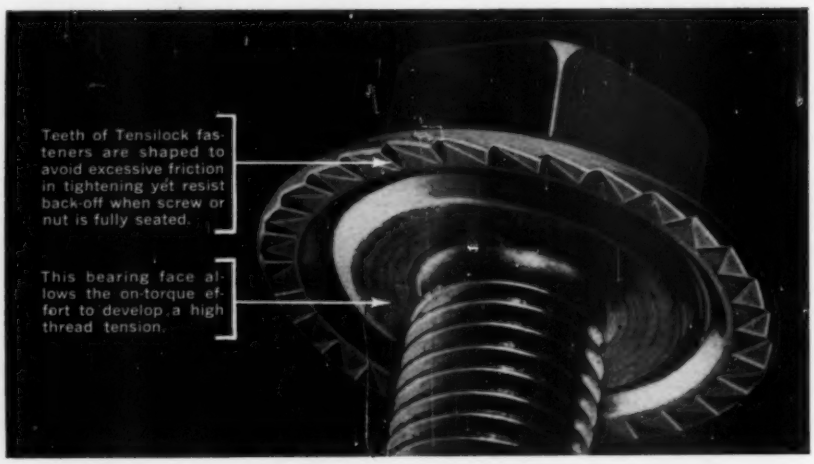
While each metal poses problems in certain applications, stainless steel, aluminum, and silicon bronze all offer distinct advantages.

Silicon bronze is popular for electrical uses due to its unusual strength, resistance to stress-corrosion, good conductivity.

Aluminum fasteners afford light weight as well as excellent conductivity. Anodized, they provide various colors; better corrosion resistance.

Widely used for fasteners, the 18-8 grade stainless steel assures good strength and excellent corrosion resistance in most atmospheres.

How Tensilock® Screws clamp tight, lock tight


Teeth of Tensilock fasteners are shaped to avoid excessive friction in tightening yet resist back-off when screw or nut is fully seated.
This bearing face allows the on-torque effort to develop a high thread tension.

TENSILOCK screws belong in the same league as high strength hex screws. With the same on-torque effort, the Tensilock units develop about 90% of the thread tension usually developed by the latter. Thus, they *both* make strong joints.

THREAD TENSION = CLAMPING FORCE

In theory, the higher the thread tension, the stronger the joint and the higher the inherent ability of the fastener to stay tight. In practice, you derive these benefits by torquing a high strength screw close to its *yield strength*. But what if you need high thread tension plus *extra* assurance that joints will stay tight? Then you have a job for Tensilock units. Not only do they develop the high thread tension, but also have an extra (and *integral*) locking device.

Screw Diameter		¼	⅜	½
Thread Tension (lbs.)	Tensilock	2,750	6,750	12,400
	High Strength Hex	2,975	7,250	13,300
On Torque (inch lbs.)	Both	120	420	1,000
Off Torque (inch lbs.)	Tensilock	150	525	1,250
	High Strength Hex	95	330	800

OFF-TORQUE = LOCKING POWER

By design, loosening torque of Tensilock fasteners exceeds tightening torque by 25% or more. This is an effective "lock." It gives that extra margin of safety against vibratory loosening.

To sum up: RB&W's Tensilock screws are stronger than Low Carbon Hex Screws; compare with High Strength Hex Screws in clamping force; are superior to them in locking action. Suggestion: For a strong locking *bolt*, use with Tensilock Nut. Send for Bulletin TL-2. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Sales office and warehouse at: San Francisco, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas.

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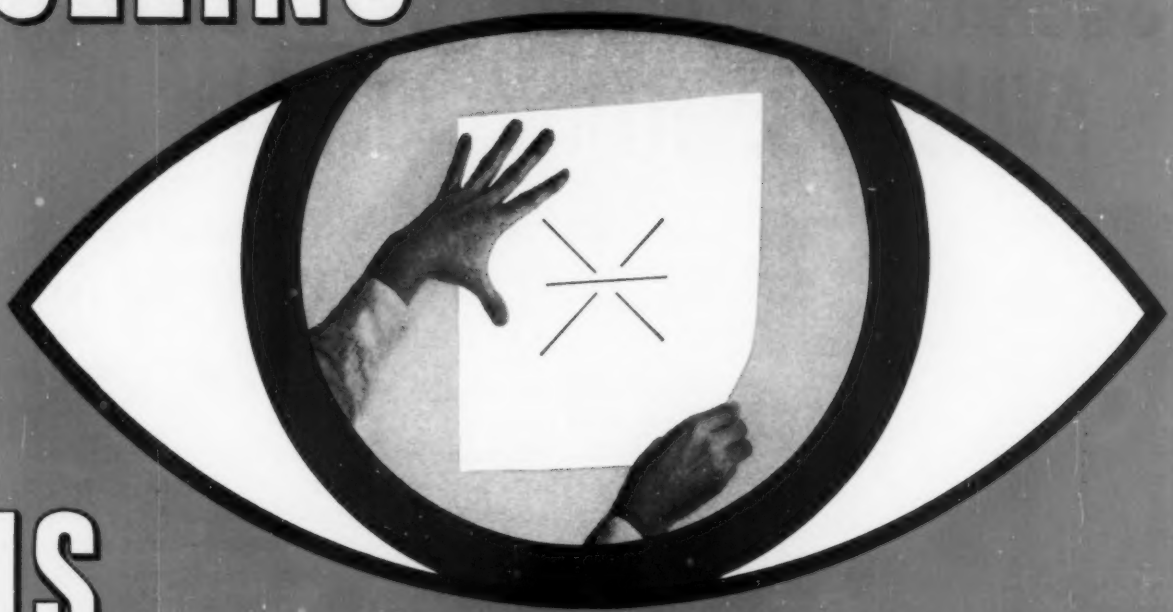

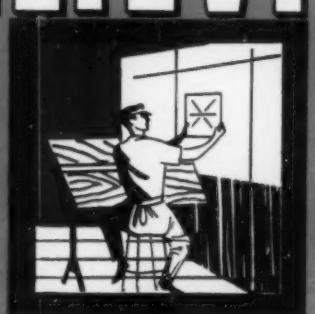

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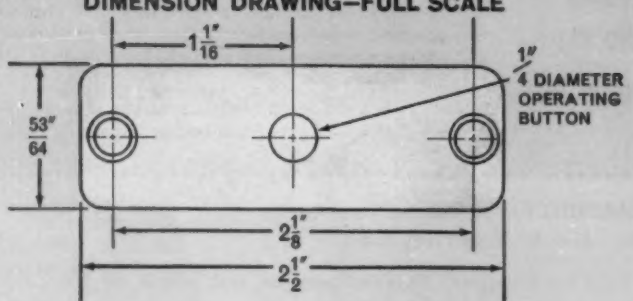

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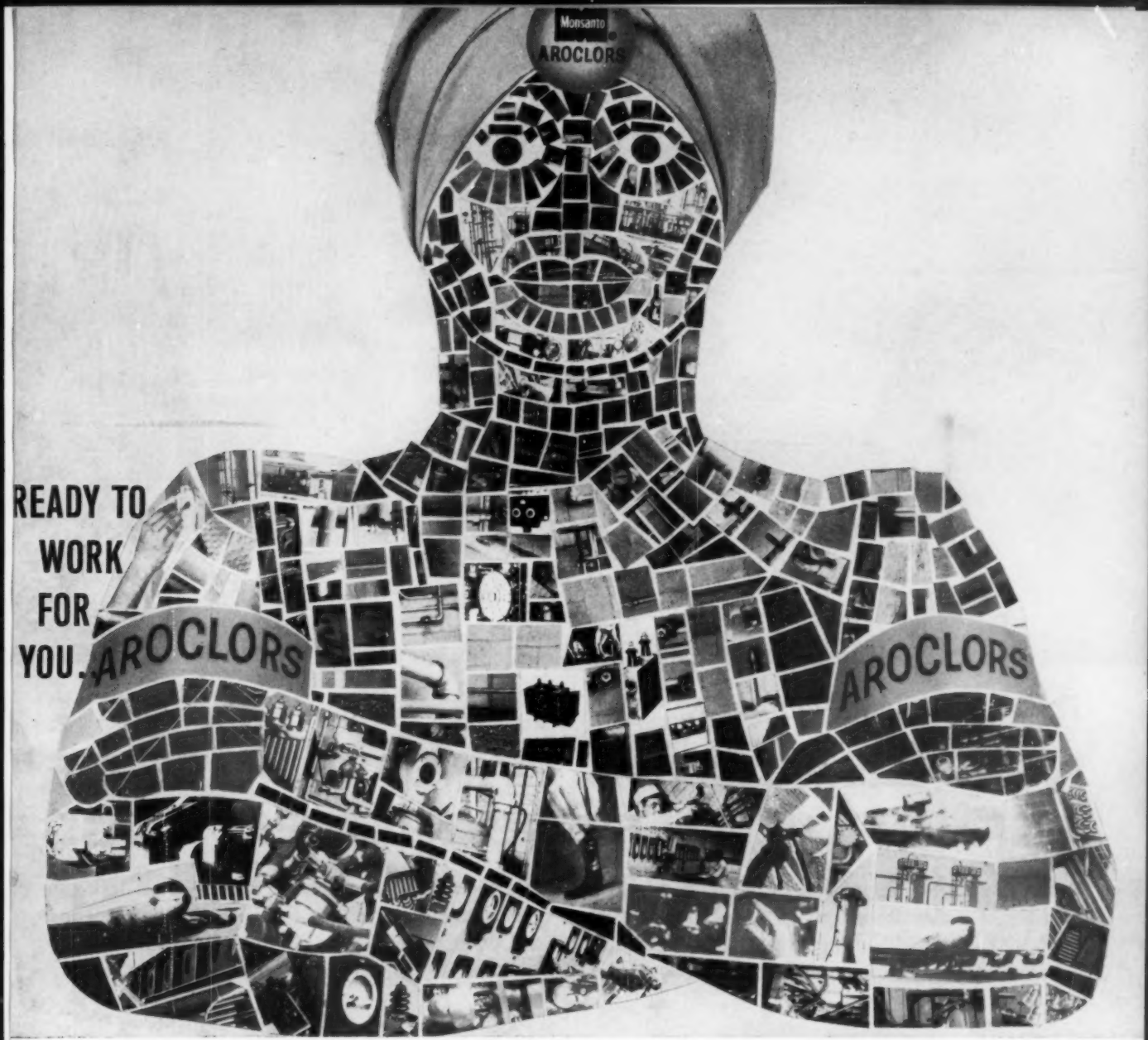

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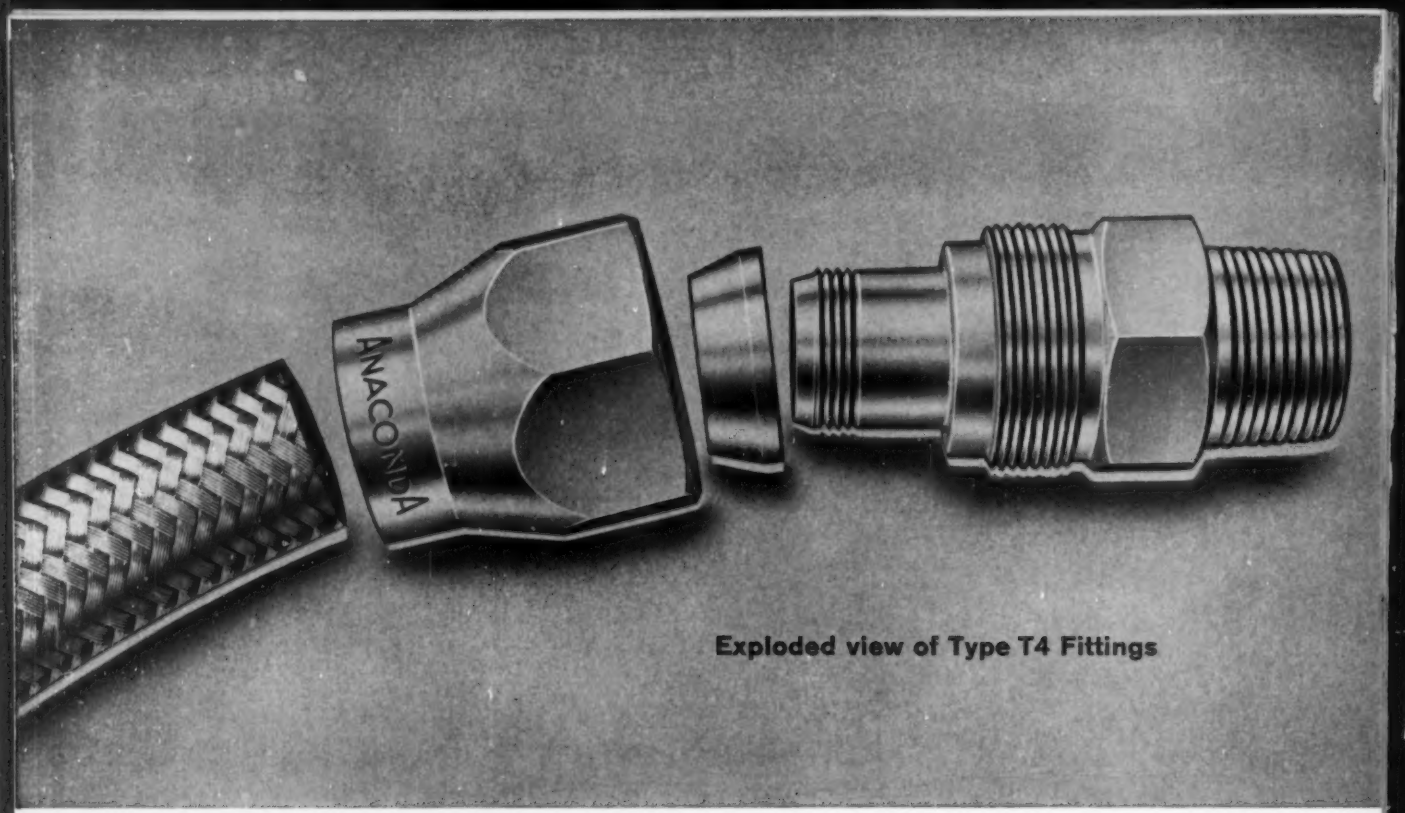

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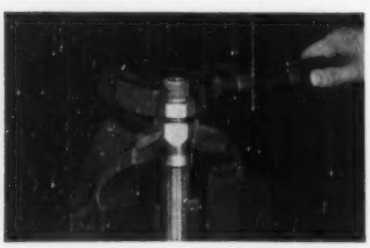

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PRODUCT ENGINEERING HORIZONS

February 6, 1961

THE MANAGEMENT PENDULUM SWINGS

Some months ago, I talked about "managerial momism" or the soft approach. This "understanding attitude" on the part of the man who once was called a "boss" has converted him into an adviser, a guidance counsellor who really either hasn't, or doesn't use, his authority. He wins cooperation by persuasion rather than by ordering something done—an excellent concept but a singularly ineffective one. It not only fails to curb the born rebel, but also adds converts to the rebel ranks, because nobody is really sure about direction in anything. It's not management, but maternal indulgence.

Reports have it that management is beginning to swing the other way. Business is not so easy to get—or to keep. There are evidences of flagrant waste in operations—costs are very badly out of line. Foreign competition is increasing steadily.

But, most of all, the quality of products is dropping. One Reliability Group head in a West Coast missile plant tells me that his investigations indicated that desired Reliability standards simply could not be met with conditions as they were. So the management has issued a fiat stating that, from now on, the executive is not just an adviser and friend—he is also the boss. The velvet gloves are off, because Reliability can only be attained, and retained, by positive action. And without reliability, a missile is just costly fireworks.

What's true in missiles is also true in other products. Reliability and quality are just words unless somebody implements them with authority. It is very good to ask for cooperation in obtaining these characteristics, but it may be necessary to have teeth in the law for non-cooperative people.

The whole situation reminds me of the evolution of our incentive system—originally a two-edged sword that rewarded the overproductive worker and penalized the underproductive one. But it gradually became purely a reward system, then often for groups rather than individuals. The union attitude seemed to be to spread any incentives across the board, to submerge the individual worker. Then the incentive (or bonus) came to be regarded as a regular part of the pay check, and any penalty clauses disappeared. We have periodically had the cases of worker groups —through their unions—suing a particular management because a traditional bonus was abandoned. The fact that the company may have needed every cent it could hang onto was not considered.

Engineers, who should be, if they are not, part of management, will be among the first affected by the change back to authoritarian control. There should be less committee evaluation of design, less babying and favoritism, less motivational research and similar ethereal approaches. There should be more straightforward decision in less time. And there should be the very desirable possibility that a design will be manufactured to the expected quality.

R. Hangeman

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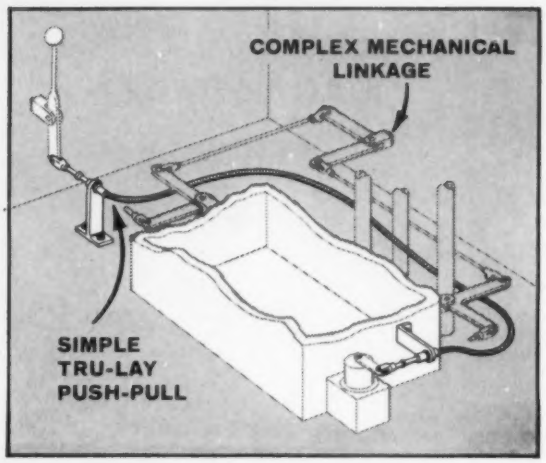

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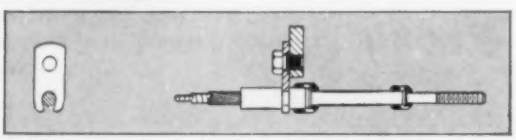

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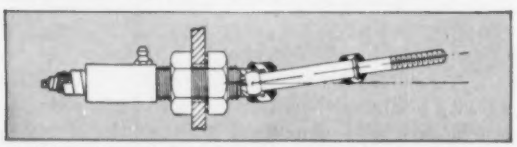

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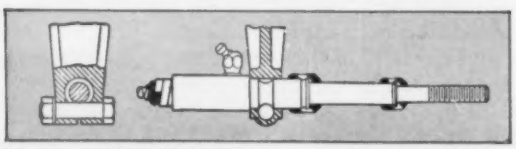

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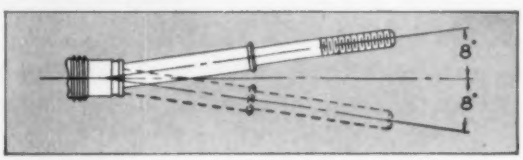

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new MAGNETIC TEST includes STAINLESS STEELS

Particles suspended in a plastic solution show up defects that older techniques miss—even in stainless steels that are normally nonmagnetic. And flux pattern can be permanently recorded on a peel-off film.

MAXWELL PEVAR, *engineering supervisor, Instruments Div, The Budd Co*

FLUX PATTERN IS STRIPPED OFF for permanent record. Its magnetic-particle image became fixed in the plastic film when solvent evaporated. For longer storage life, water-soluble film is sprayed with lacquer.

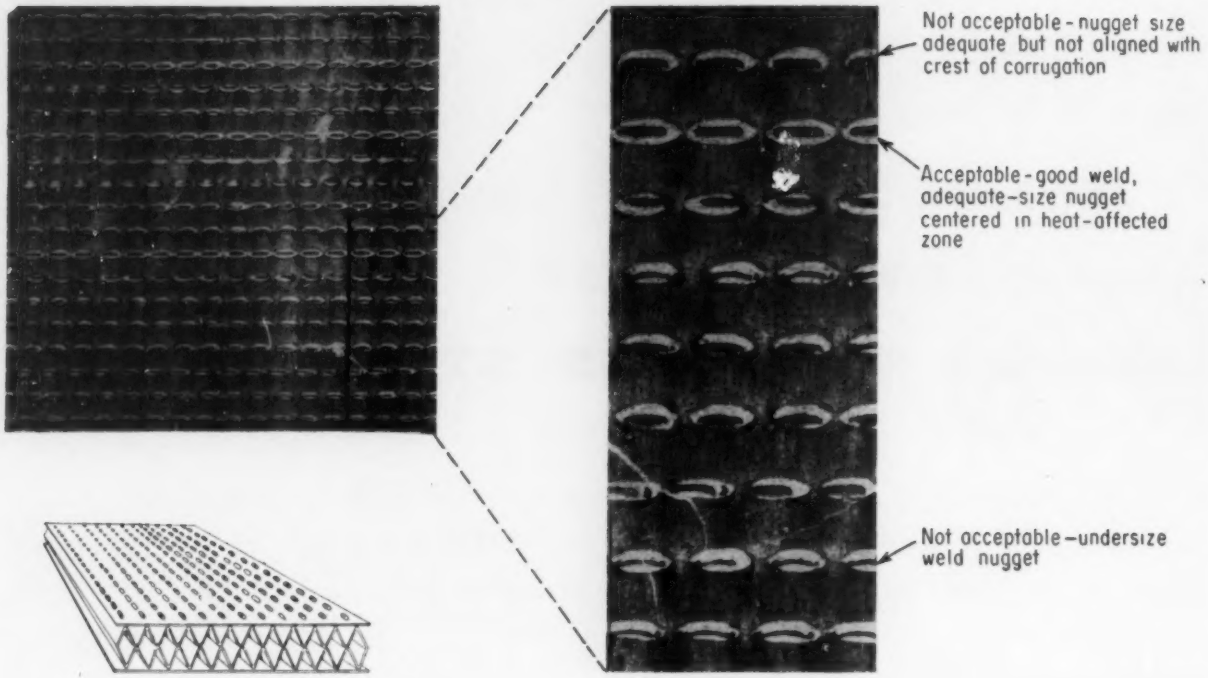
Testing with magnetic particles will find cracks in magnetic steels. But a new version of this technique, in which the particles are suspended in a plastic solution, has applications that include most stainless steels, and leaves a permanent record. This method, developed by The Budd Co and called Recordaflux, shows up cracks in stainless steels that are normally nonmagnetic. Even more valuable, it reveals the size of spot-weld nuggets in cold-rolled stainless and other steels.

How it works

To perform the test, the solution containing the magnetic particles is sprayed or washed onto parts held in a magnetic field. The particles migrate to outline any magnetic discontinuities. Visual inspection is made immediately. The water-soluble plastic is then washed away unless a permanent record is wanted; if so, the magnetic flux is held in the part while the solvent evaporates. (This takes about 30 minutes in normal air drying, but can be quickened by heating.) The plastic film is then reinforced with a pressure-sensitive tape and stripped or lifted from the part for storage. This film record gives even better visual contrast and detail when viewed in a lightbox or against a white-paper background.

Magnetic-particle analysis of stainless steel is possible because most stainless steels like 301, 201, 302, PH 15-7 Mo and AM 355 transform partly during cold rolling or

Weld analysis in an all-stainless sandwich panel with corrugated core

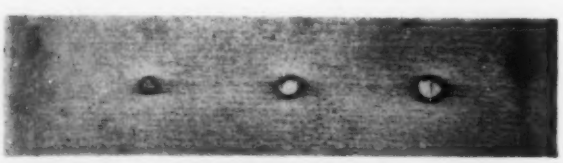

Not acceptable - nugget size adequate but not aligned with crest of corrugation
Acceptable - good weld, adequate-size nugget centered in heat-affected zone
Not acceptable – undersize weld nugget

heat treatment to martensite, which is magnetic. Magnetism increases with the degree of cold reduction, and much of the stainless sheet used is either cold-worked or heat-treated anyway—to obtain higher mechanical properties.

How spot welds are shown

Magnetism reveals spot-weld size because the resistance-welding heat produces different magnetic permeabilities in the solidified weld nugget, the annealed heat-affected zone, and the parent metal. When the spot weld is placed in a magnetic field, change in magnetism from one area to the next is enough to attract magnetic particles that delineate the edge between each of these areas.

Nugget size measured by this method usually is slightly smaller than the maximum nugget diameter measured by cutting and etching the weld. Lack of fusion in cold welds produced with inadequate heat is revealed by a blurred magnetic image. Over-size or hot spot welds are also revealed, although they are usually acceptable since they meet tensile- and shear-strength requirements. For fatigue applications, however, these oversize spot welds are undesirable because of the possible weld-metal expulsion that will increase notch effect.



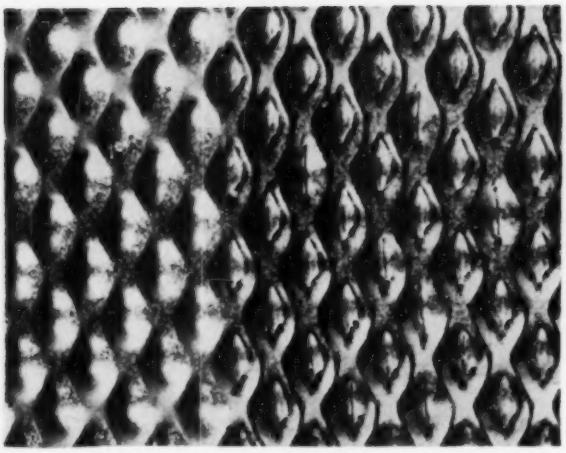
TENSILE AND SHEAR STRENGTH is predicted by nugget size. Center weld in Recordaflux pattern is acceptable size. Blurred image, left, shows lack of fusion. Oversize nugget, right, shows hot spot weld. While this type weld will have adequate tensile and shear strength, it may also have weld-metal expulsion, which lowers fatigue.

Nondestructive weld-nugget measurement can be done on any steel that has sufficient magnetic difference between weld and base metal. This includes the partly magnetic materials like cold-rolled stainless steel, semi-austenitic steels like PH 15-7 Mo, medium carbon steels and alloy steels like 4130 and 4340. It will not measure spot welds in low-carbon steels like 1010 and will not detect flaws in completely nonmagnetic stainless steels like A-286.

Reliability in spot welds

For moderate-gage sheet, best diameter for a spot weld is 4 times the sheet thickness. In this size, shear area of the nugget is equal to shear area in the sheet around the nugget. Once the welding-machine settings are established by destructive tests on test coupons and a nugget-size measurement is obtained, welds in the structure that have the correct magnetic size measurement will meet requirements for tensile, shear and fatigue strength. Cold or undersize welds with low strength can be rewelded.

In contrast, conventional spot-weld control depends upon destructive tests on test coupons made periodically during the production run.



CRACKS IN STAINLESS STEEL are revealed by magnetic-flux pattern at right. Vertical cracks originate at high-strain area—dark spot at bottom of crack—and progress upward. Magnetic particles also show diamond pattern, indicating plastic strain which increases magnetism in the 301 stainless. In untreated area, left, cracks are not visible.

Other nondestructive tests such as X-ray and ultrasonics cannot show actual nugget size. X-rays will reveal shrinkage and weld cracks but the circular pattern obtained from X-ray is only the indentation caused by electrodes, and indentation size is not an indication of nugget diameter. In fact, a sizable surface indentation can be made with no nugget at all.

Ultrasonic tests will reveal when the two parts are not bonded but will not detect a weak bond caused by a cold weld. Also, ultrasonic methods probe each spot weld individually and are impractical for assemblies with a large number of welds.

EDITOR'S NOTE: For other articles dealing with stress analysis and design techniques that help improve reliability in highly stressed parts:

Allowable Stresses in Flash-welded Joints, Oct 31 '60, p 39—How to correlate fatigue data with magnetic inspection to give practical stress levels in flash-welded parts.

Visual Strain Gage Does Work of Three, Oct 24, '60, p 42—Photoelastic rosette equipped with built-in polarizer separates and measures principal strains, giving direct readout of fringe displacement.

A Double-deck Resistance Strain Gage, Oct 10 '60, p 55—Two-element strain-gage, assembly-mounted on one side of the structure, separates bending strain from axial strain. This eliminates awkwardness of the conventional back-to-back arrangement.

How to Get Stronger Parts From Work-hardened Sheet-metal, Oct 26 '59, p 76—Take advantage of high strength in cold-worked steels.

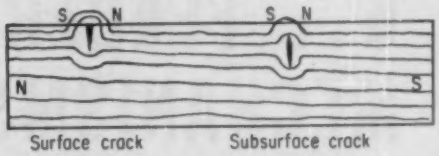
A Manual of Reliability, May 16 '60, p 65—Comprehensive report shows how to design mechanical reliability into parts. Reprint copies of this manual are available for 50 cents each from our Reader Service Dept.

—Herbert Kee

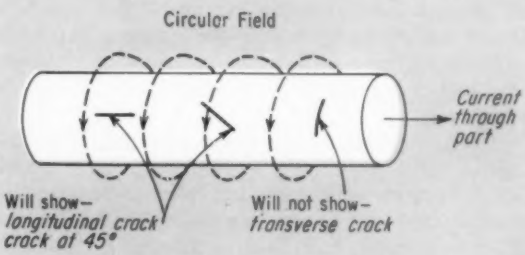
HOW MAGNETIC PARTICLES DETECT CRACKS

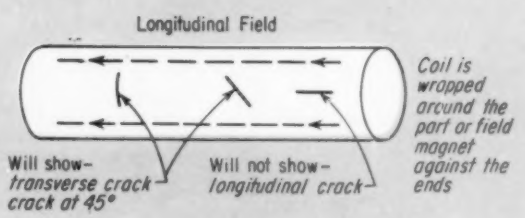
■ To detect cracks, a magnetic field is induced in the part and magnetic particles are sprayed or dusted on. The crack forms north and south poles; these attract magnetic particles that visually delineate the defect. Similarly nonmagnetic inclusions below the surface will cause airgaps and force flux lines to pass around, creating extra poles where they leave the part.

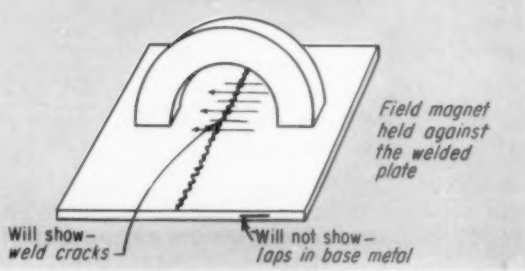
Indications of subsurface cracks or defects become less distinct with increased depth.



Visual resolution is best when the flux direction is perpendicular to the crack. A circular field brings out longitudinal cracks or seams but hides transverse cracks. A longitudinal field shows transverse but hides longitudinal cracks. Weld defects in plates or sheet are best revealed by a longitudinal field.







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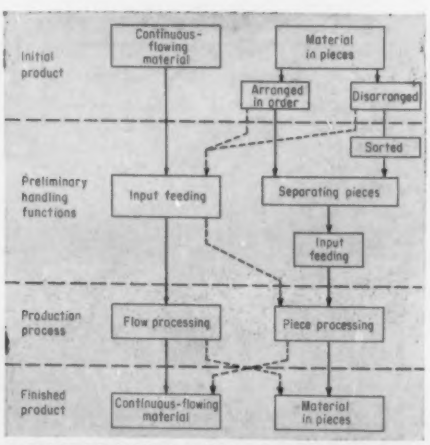
H SCHAEDLER and G MARX
Institute for Fundamental Research
Brunswick, Germany
Translated by F R Erskine Crossley, Yale University

6...FEEDER MECHANISMS—types

How to perform systematic analysis of individual motions and translate them into mechanisms—the basic steps for precise design of feeder mechanisms.

Feeding parts into a continuous or piece-processing machine involves many complex motions. First step in a systematic analysis is to catalog the motions, determine the minimum actual time duration, and coordinate complementary motions. Second step is to translate these motions into hardware.

Feeder mechanisms can be classified according to type and stage of the process, Fig 1. This diagram is divided vertically, between continuous and piece-processing; and horizontally into four process stages. Continuous-flow material can be granular, bulk, fluid, or continuous strip. Furthermore, the production process can change the form of the material from continuous-flow to piece-processing or vice versa as shown by dotted lines in the chart.



1 FEEDER-MECHANISM REQUIREMENTS here are classified according to type of material and processing stage.

Generally, mechanisms are more complex in the piece-processing operation, although some continuous-flow operations require auxiliary mechanisms for feeding or removal. In sheetmetal processing, auxiliary mechanisms may be needed on fixed or adjustable universal strip-metal presses, special-purpose self-actuating presses, or shearing, bending and forming machines. Mechanisms for continuously advancing strip and sheetmetal combine feeding, advancing and removal; and employ cams, tongs or grippers, or rolling clamps.

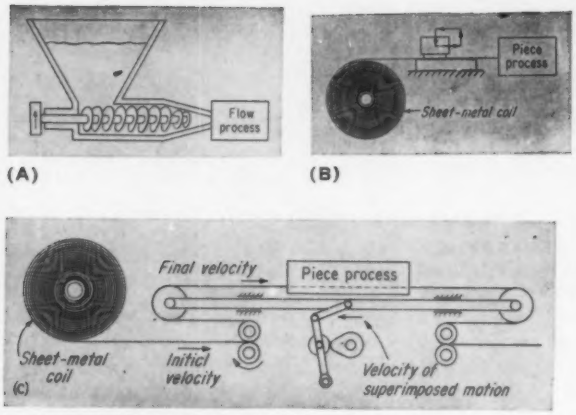
By contrast, a piece-processing mechanism performs these functions:

- Hopper loading, which requires supplying and introducing the material.
- Arranging, separating, turning, shaking, and directing.
- Holding with means for charging or removing from the machine.
- Transferring product to the next machine.

Small parts can be advanced by gripping jaw or turntable carriers with cam, geneva or gear drives; by compressed-air-actuated feed mechanism; by sliding track or plunger; or by a pushing mechanism.

Preliminary handling functions

In a continuous-flow process, the handling functions that precede actual processing largely consist of continuously withdrawing material from a steady source of supply, and feeding it into the process at a predetermined rate. Mechanisms for such functions are relatively simple, as shown in (A) of Fig 2.

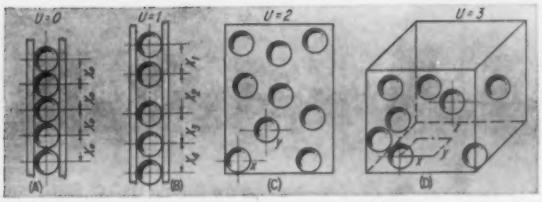


2 CONTINUOUS FLOW. (A) Screw feeders in many forms are used to feed continuously flowing bulk material at a predetermined rate. (B) Continuous sheetmetal is fed into a piece process by an intermittent motion—which can be furnished by a crank and lever coupled to a ratchet mechanism. (C) Intermittent motion can be applied to a sheetmetal coil by superimposing a second motion of a cam brake.

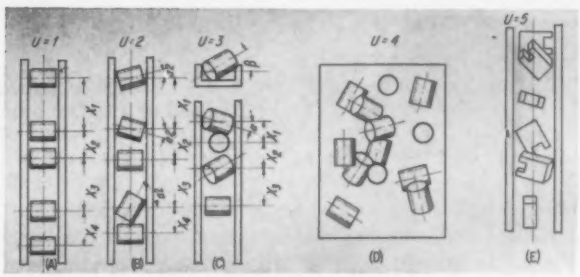
A continuous-flow process feeding into a piece process, Fig 2(B), sometimes requires intermittent motion, as in stamping presses, sewing machines and film projectors. Another example of continuous material feeding into a piece process is shown in Fig 2(C) where a secondary motion by a cam is superimposed on the uniform initial velocity of the sheetmetal coil in such a way that the final velocity of the sheet is zero.

In the piece process, degree of difficulty required to produce some orderly arrangement of the pieces can be defined in terms of parameter U, or the "degree of disorder" of the individual pieces. For example, if uniform spherical pieces fit a grooved guide, then the distance between them is nominally zero. This is sufficient to determine their relative positions; thus $U = 0$ as at (A) in Fig 3. However, if the balls are to be spaced at different intervals, as in (B), one dimension becomes necessary to determine their positions, and $U = 1$. To establish positions of the balls in contact with a given plane, two coordinates are needed as in (C), and $U = 2$. But to establish a systematic order of the balls within the space of a container, three dimensions are required as in (D); here $U = 3$.

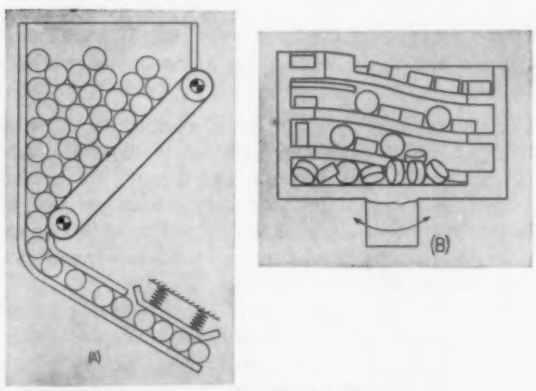
Handling cylindrical pieces is somewhat more complicated than handling spherical pieces. Fig 4(A) shows that $U = 1$ when only one dimensional factor is required to establish the positions. When one dimensional factor and one angular factor are required, $U = 2$, as in (B). When one dimensional factor and two angular factors are required, $U = 3$, as in (C). To establish positions of the cylinders in contact with a given plane, two coordinates and two angular factors are required, which makes $U = 4$ as in



3 DEGREES OF DISORDER of spherical parts depend on number of dimensions required to specify the position.



4 FOR CYLINDRICAL PARTS, degrees of disorder depend on number of dimensions and angles required to specify the position. Similarly, in (E) degrees of disorder of odd-shape parts depends on number of dimensions and angles, and their relation to a reference plane.



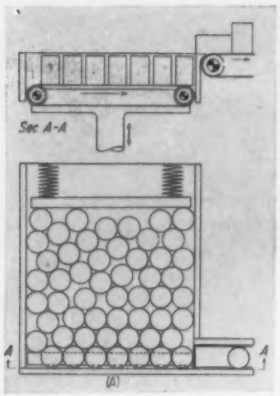
5 MAGAZINE LOADING OF PARTS can be done a number of ways. In (A) gravity-fed balls are slowed down by a spring-actuated device. In (B) a vibrating or oscillating drum elevates parts that fall on grooves specially designed to fit the parts.

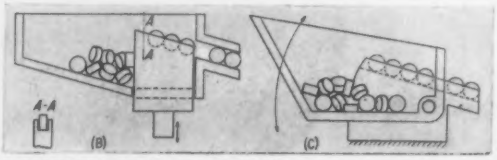
(D). To establish a position for the cylinders in space, the value of U increases to 5. The degree of disorder of odd-shape objects, as in (E), is also 5 since their position is determined by two geometric axes and by the surface planes of the object.

Mechanisms for preliminary handling

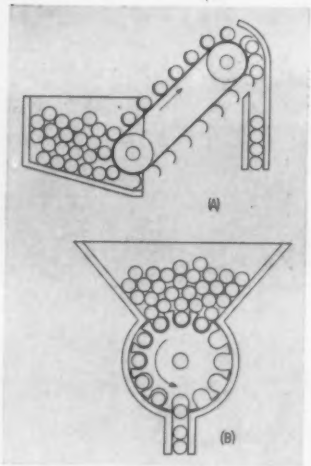
Three general methods of sorting and arranging, independent of the degree of disorder are: continuous sorting, sorting into groups, arranging by individual separation.

Continuous sorting sets in order a group of disordered parts steadily yet not in any exactly predictable time, Fig 5. When sorting into groups a few disordered parts are





6 SORTING INTO GROUPS by a spring-actuated device can be applied either horizontally or vertically as in (A); can also be done by vertical oscillation (B), or by angular motion (C).



7 ARRANGING BY SEPARATING: (A) by a belt conveyor with specially fitted cogs; (B) by rotating grooves.

separated and forced into a desired orderly position, Fig 6. To arrange by individual separation, a single piece is selected from a disordered quantity, and taken off in a constrained manner as shown by the several varieties in Fig 7.

Mechanisms for input and removal

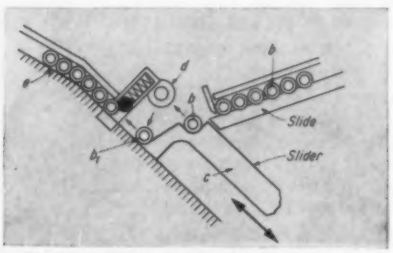
Mechanisms for control and positioning the part involve two principal factors:

- Space limitations surrounding the machine entrance.
- Accessibility of the mechanism to the central working position of the machine.

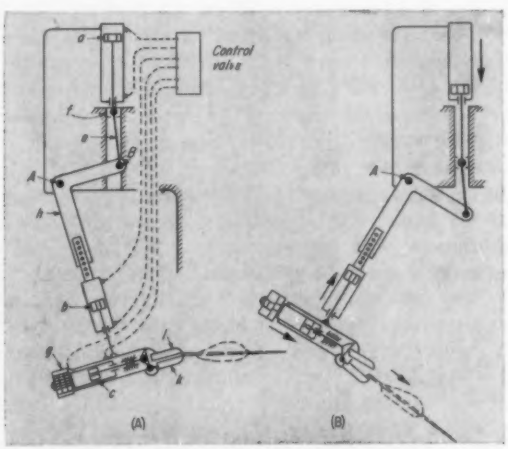
Also, the number of free or forced movements must be considered. Free or gravity movements require mechanisms to control their direction and velocity, but forced movements require mechanisms that actuate as well as guide the movements, and more complexity adds to cost. However, mechanisms that actuate forced movements are positive, and therefore more reliable.

Removal of parts from a processing position requires fewer movements, and consequently less-complex mechanisms. Primarily, this is a transfer operation, in which the parts are forced out, or fall out of the machine. Fig 8 shows an arrangement for simultaneous input and removal from a machine. The tubelike workpiece *b* rolls out of the feed magazine *a* into a recess in the slider *c*. It is then advanced into the work station by the forward stroke of the slide, and carried into the machine by a ramrod (not shown). At the same time a previously finished part rolls down the inclined surface of the slider, and on the next stroke is pushed into the transfer channel.

An arrangement that uses complex forced movements for feeding and gravity movements for removal of parts is shown in Fig 9. Three power cylinders a, b, c connected to an adjustable bell crank are used to generate the forced movements required to feed sheetmetal into a machine. Removal by gravity occurs after the part has been directed by forced movements into the desired direction.



8 INPUT AND REMOVAL OF PARTS can sometimes be done with a single mechanism. In this unit, slider *c* simultaneously pushes incoming part *b* and outgoing part b_1.



9 ADJUSTABLE BELL CRANK pivoted at *A* provides the angular motion while 3 air cylinders with a central control valve provide the linear motion. Counterbalancing is provided by adjustable weights *g*.

From the text for the Refresher Course in Mechanism 1959/1960, arranged and sponsored by the Chamber of Commerce & Industry of the City of Brunswick, Germany, in cooperation with the Division of The Science of Mechanism of the Society of German Engineers (VDI). Course director: Kurt Hain.

REPRINTS: The nine articles in this series will be available as a combined reprint for $1.00 after the series is complete. Address: Reader Service Department, Product Engineering, 330 W 42nd St, New York 36.

how linear are FLOW-CONTROL VALVES?

Here are 8 commonly used direct-action valves and their response curves at a glance—together with specific response equations for plotting the curve you need

LOUIS DODGE, *New Richmond, Ohio*

No manufactured valve has a completely defined flow path. Actual configuration is some combination of orifice, nozzle, pipe, miscellaneous obstructions such as rough surfaces, sharp bends, and sudden contractions or expansions.

How then do you develop a rigorous flow equation? The answer is you don't. But you can assume the whole valve behaves like an orifice with a discharge coefficient of 0.64. (Actually for hydraulic oil most valves will have discharge coefficients ranging between 0.58 and 0.72, unless specifically designed for high flow.) Based on the average coefficient, the flow may be calculated from the following familiar equation:

$$Q = CA\sqrt{gh}$$

where C = discharge coefficient = 0.64
A = sq in. of orifice area
h = pressure drop across the valve, in. of column height
Q = flow, cu in. per sec
g = gravity acceleration, in. per sec²

More simply, in terms of pressure drop across the valve and for hydraulic oil:

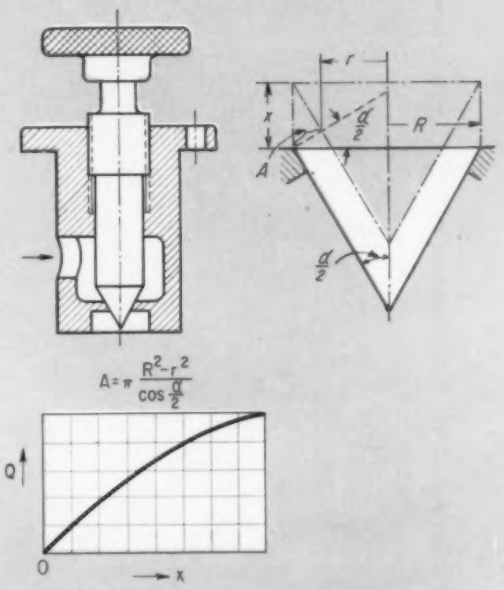
$$Q = 100A\sqrt{\Delta p}$$

where Δp = pressure drop in psi, and the constant 100 includes the discharge coefficient, gravity acceleration, and the other necessary conversion factors.

Since the area, A, is a calculable function of control movement x, Q may be established for any particular valve as a direct response function of control movement.

Each of the 8 common valves sketched here is accompanied by its response equation plus a graph of the response characteristic, allowing you to see its general response pattern at a glance. You will want to be a little careful in applying these relationships since pressure drop has been assumed to be constant throughout—an unlikely situation in any real hydraulic system but one that is useful in theoretical analysis of system designs.

1. Needle Valve



1

To solve for A, you must determine r, which, in terms of valve movement, is:

$$r = R - \frac{x}{2}\sin\alpha$$

when $r = 0$ and $\frac{\alpha}{2} = 0$

A is the surface of the frustrum of a cone. A good approximation of this area is simply the difference between top and bottom areas divided by $\cos\frac{\alpha}{2}$.

continued, next page

For REPRINT of above article, just check 583 on one of the Reader Service cards found in this issue.

EDITOR'S NOTE: We will publish an article discussing nonlinear valves shortly.

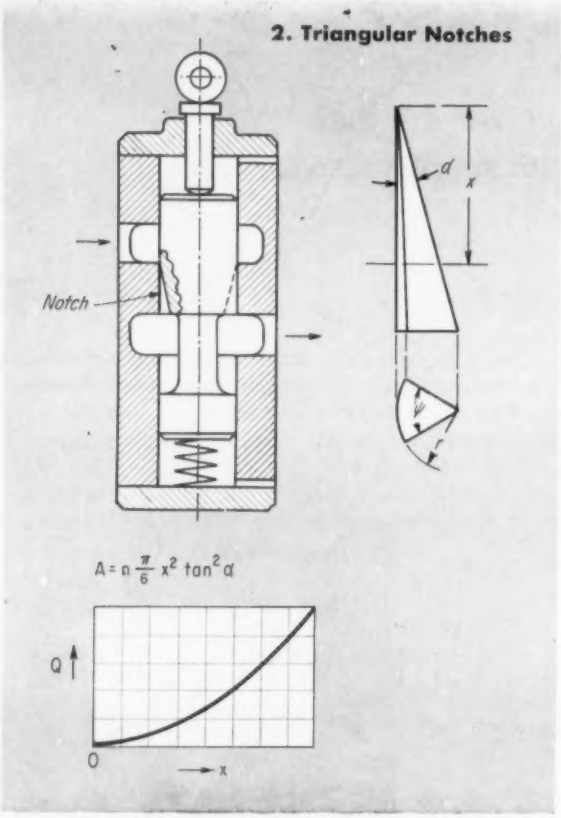
A survey of all types of flow control valves, with cross-section views and important characteristics described, is found in these previous 5 articles:

Relief Valves, Dec '56, p 174; **Pressure-control Valves,** Jan '57, p 196; **Flow-control Valves,** Mar 57, p 144; **Directional Valves,** May '57, p 167; and **Valve Circuits,** July '57, p 197. These articles have also been incorporated in a book: *Fluid-power Controls,* Pippenger and Koff, available from McGraw-Hill Book Co.

—F E Hall

FLOW-CONTROL VALVES

continued



2 Cross-sectional area of any one of the series of evenly spaced notches (n = number of notches) on the circumference of the spool is:

$A = \frac{1}{2}\psi r^2$ where ψ is the notch angle in radians.
Also, from sketch, $r = x \tan \alpha$

Therefore, in usual configuration, where $\psi = 60° = \frac{\pi}{3}$,

substitute $\frac{\pi}{3}$ for ψ in general equation above.

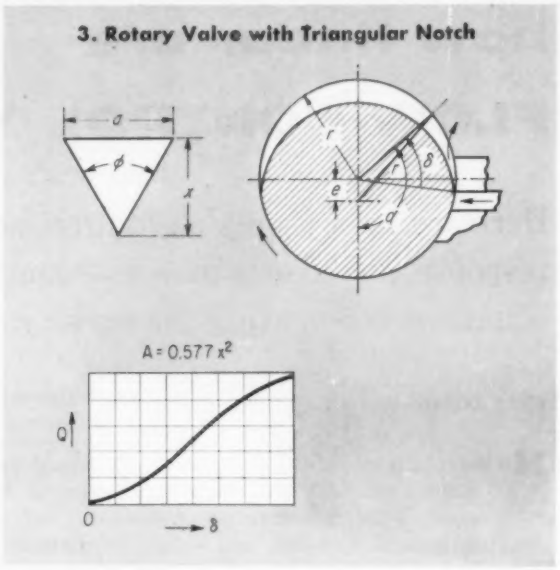
4 For a negative Archimedian spiral starting at $\delta = 0$ and $r = R$:

Flow area $A = wx$ where w is width of groove and $x = a\,\delta$ where a is constant.

For example:

let maximum $x = 0.25$ at $\delta = \pi$

then $a = \frac{x}{\delta} = \frac{0.25}{\pi} = 0.079$.



3 To keep it simple, assume both radii equal. Then, from the law of cosines:

$$x = \sqrt{e^2 + r^2 - 2er\cos\alpha} - r$$

When the valve in closed $x = 0$

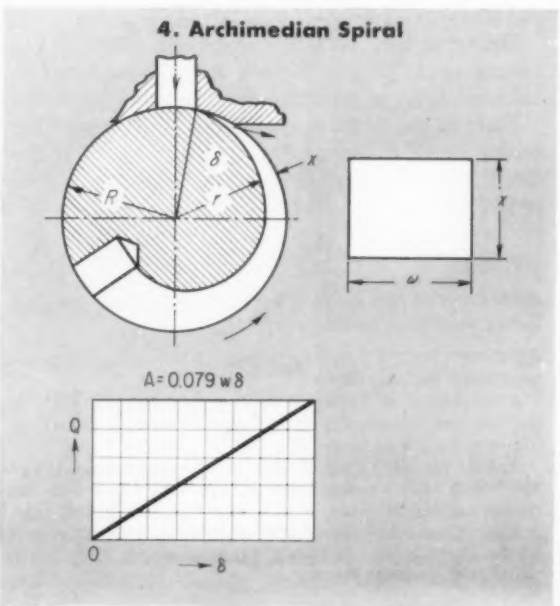
and $$\cos\alpha = \frac{e}{2r}$$

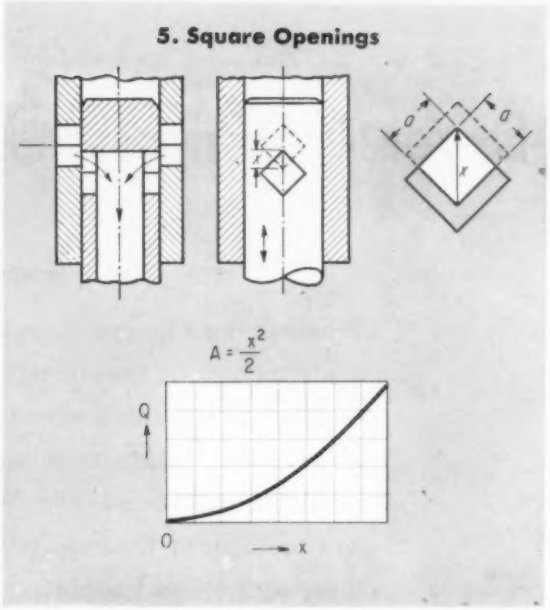
Area of opening is

$$A = \frac{a\,x}{2} \qquad a = 2x\left(\tan\frac{\phi}{2}\right)$$

ϕ is usually 60°, so $\tan\frac{\phi}{2} = \tan 30 = 0.577$:

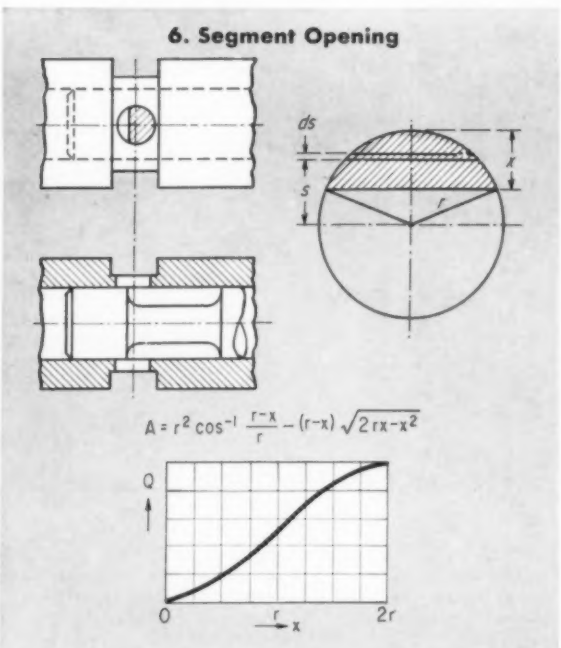
The curve is plotted versus δ, a measure of plug rotation away from the point at which x is 0.





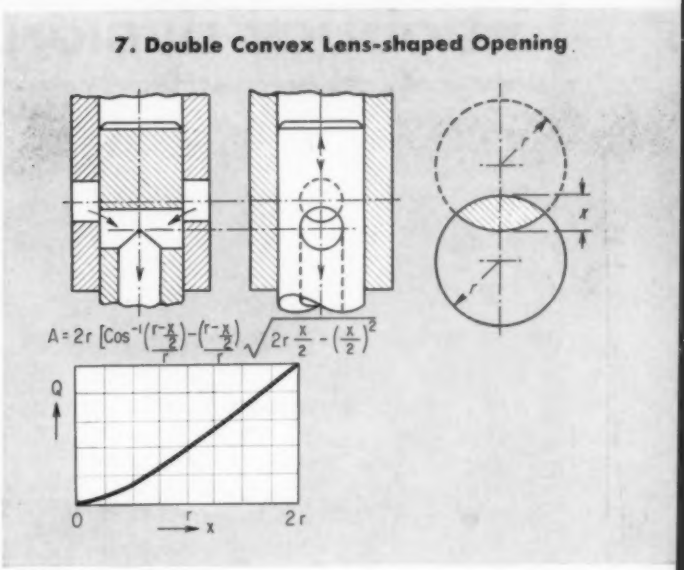
5 The axial plunger contains two square openings. When moved, these openings can match two smiliar openings in valve body.

$$A = a^2 \text{ and } a^2 = \frac{x^2}{2}$$

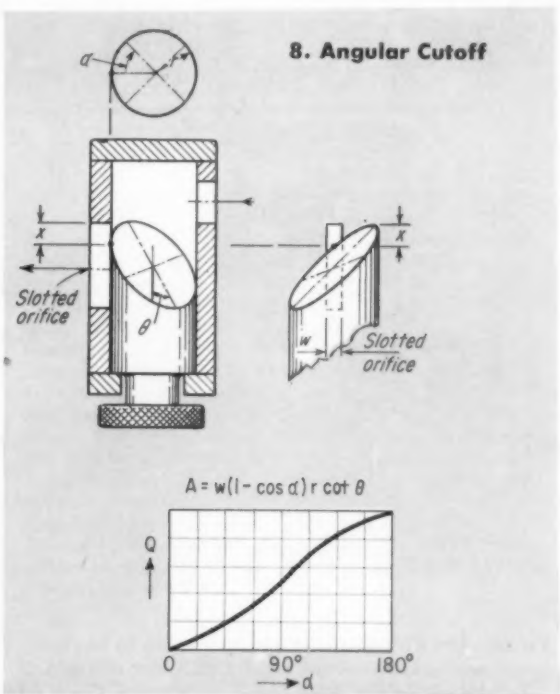


6 Sharp-edge shoulder of spool moves across the round port hole.

Area of two segments is given by the equation shown or can be found in tables of segment areas. See also PE—Feb 16, '59, p 72 for an article on "Universal Tables for Circular Segments and Sectors."



7 Two circular openings move across each other. Area is calculated by substituting $\frac{x}{2}$ for x in equation with Fig 6 and doubling:
Area may also be found in tables; see PE—June 20, '60, p 81 for an article on common area of intersecting circles.



8 Valve progresses from fully closed to fully opened in 180° travel of spool. The ellipse progressively clears the slot and we calculate the height of the intersection of the ellipse with the center of the slot to be

$$x = r \cot \theta \, (1 - \cos \alpha)$$

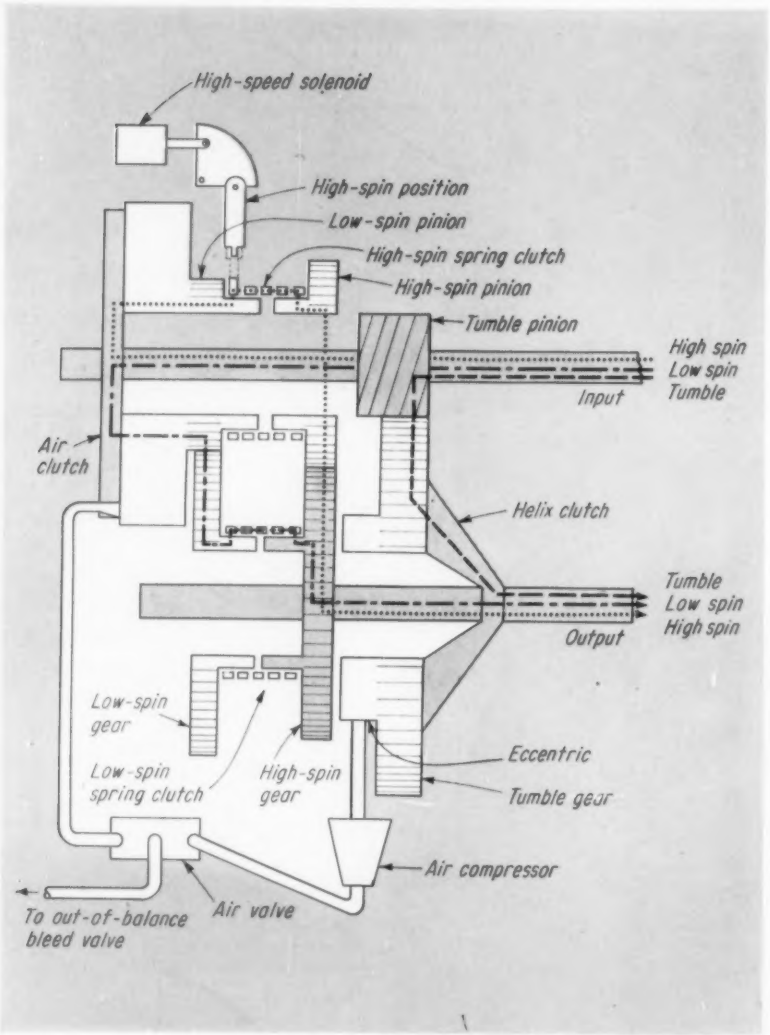
Note that r and θ are constants.

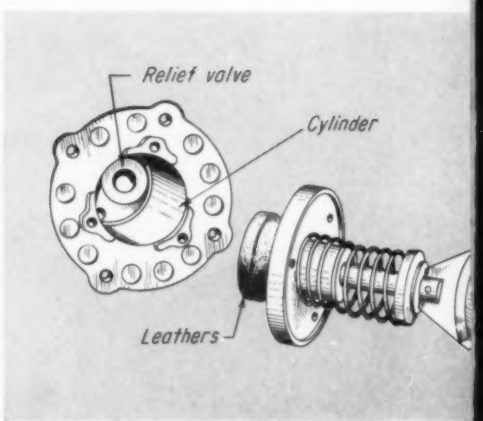
$$A = wx$$

PRODUCT DESIGNS

Washer-Dryer Transmissions:

Whether done by gears, separate motors or variable-diameter pulleys, these mechanisms must rotate a drum at different speeds. Here's how designers have solved these and related problems.





THREE-SPEED GEARBOX changes ratios by engaging different sets of constant-mesh gears with four clutches.

Tumble—Only the helix clutch engages. Tumble pinion always drives tumble gear; but at higher speeds, output shaft overrides the helix clutch.

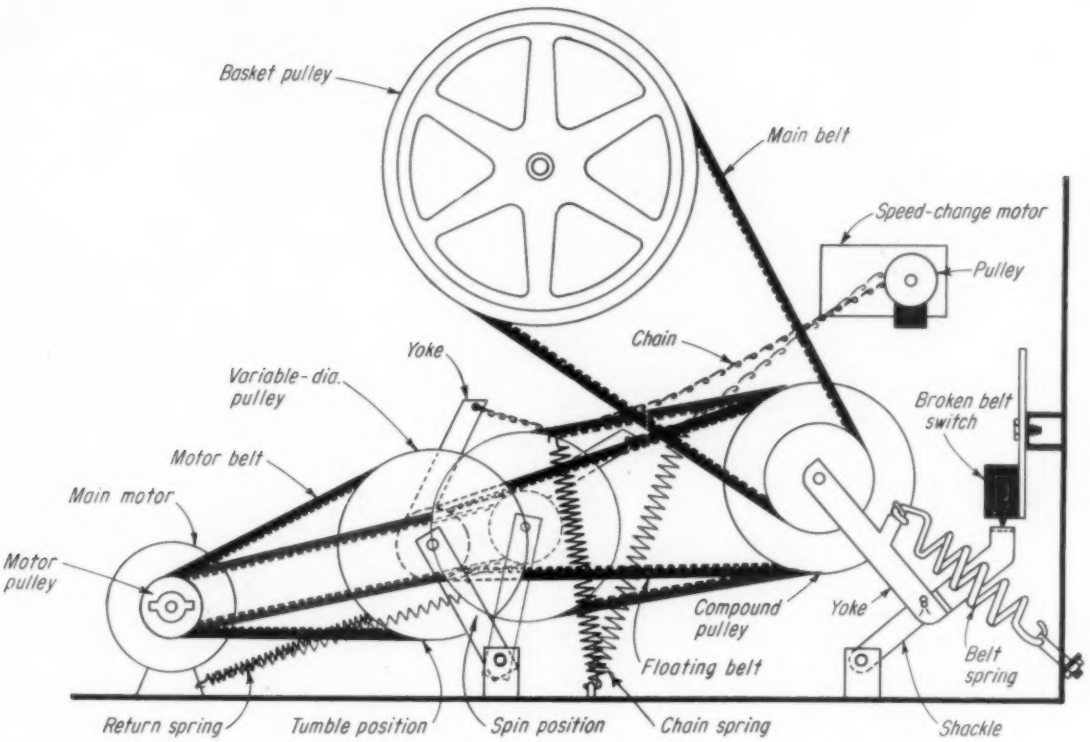
Low spin—Alter low-spin signal, air valve directs pressure from compressor to air clutch, engaging input shaft to low-spin pinion. With high-speed spring clutch disengaged, power goes through low-spin gear, by one-way low-spin spring clutch to high-spin gear, which connects to output shaft.

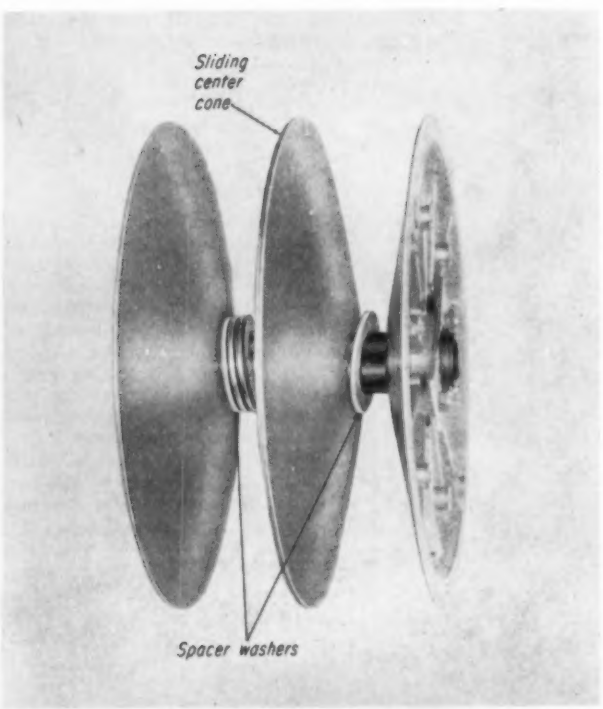
High-spin—Energizing the high-speed solenoid retracts the rod which holds the tang of the spring in the high-spin spring clutch. Spring then wraps around the gear hubs to connect low-spin pinion to high-spin pinion, which is in mesh with high-spin gear connected to the output shaft.

Excessive vibration because of an unbalanced load in the drum tickles the air-bleed valve (which is like a tire valve); now air pressure on clutch drops, clutch slips, and drum slows down.

AIR COMPRESSOR (above) supplies 25-psi air to operate air clutch. Eccentric on tumble gear drives leather piston 240 strokes per minute, (Whirlpool Corp, St Joseph, Mich).

Three Ways to Multiple Speeds





VARIABLE-DIAMETER PULLEY system uses no clutches and no solenoids.

To shift from tumble to spin, the speed-change motor switches on, pulling chain attached to the variable-dia pulley. Center cone of this pulley is free to slide laterally. When pulley moves away from the main motor, the motor belt wedges into a smaller diameter on the pulley, at the same time pressing the center cone against the floating belt, forcing it out to a large diameter. These motions continue until center cone jams against spacer washers. Thickness of these washers on either side of the center cone determines the high and low speeds.

Vibration during spin trips the switch, shutting off change of speed motor and returning machine to tumble. Time-delay mechanism allows load to redistribute before it turns on speed-changer motor again. (General Electric Co, Appliance and Television Receiver Div, Louisville, Ky)

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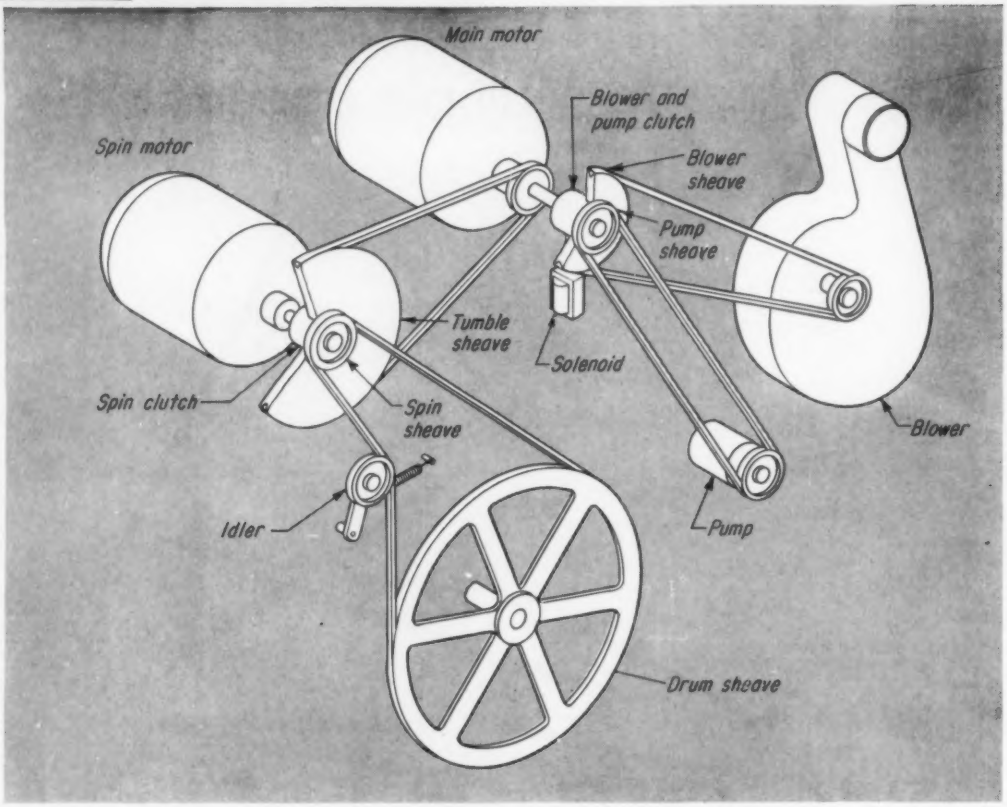
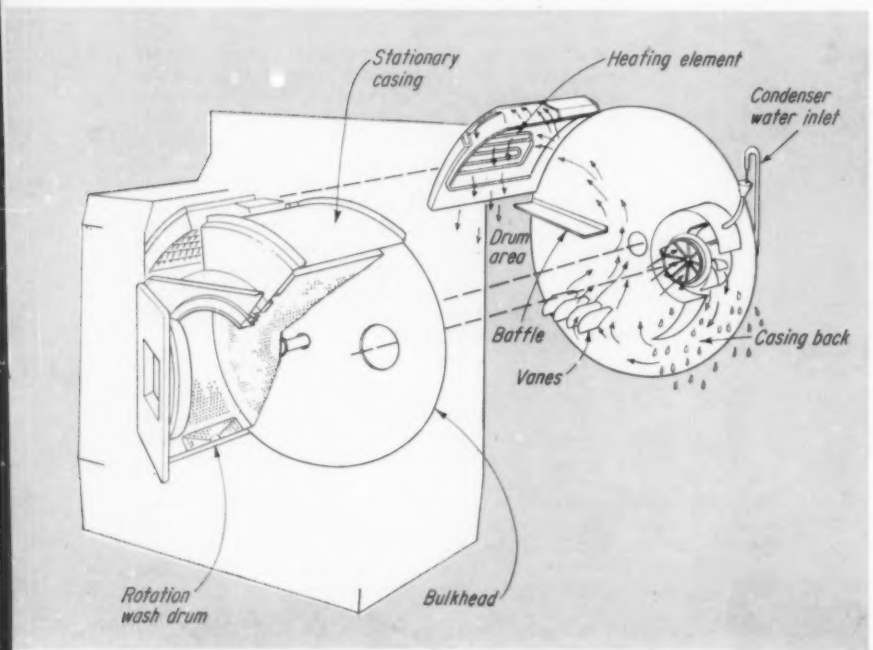


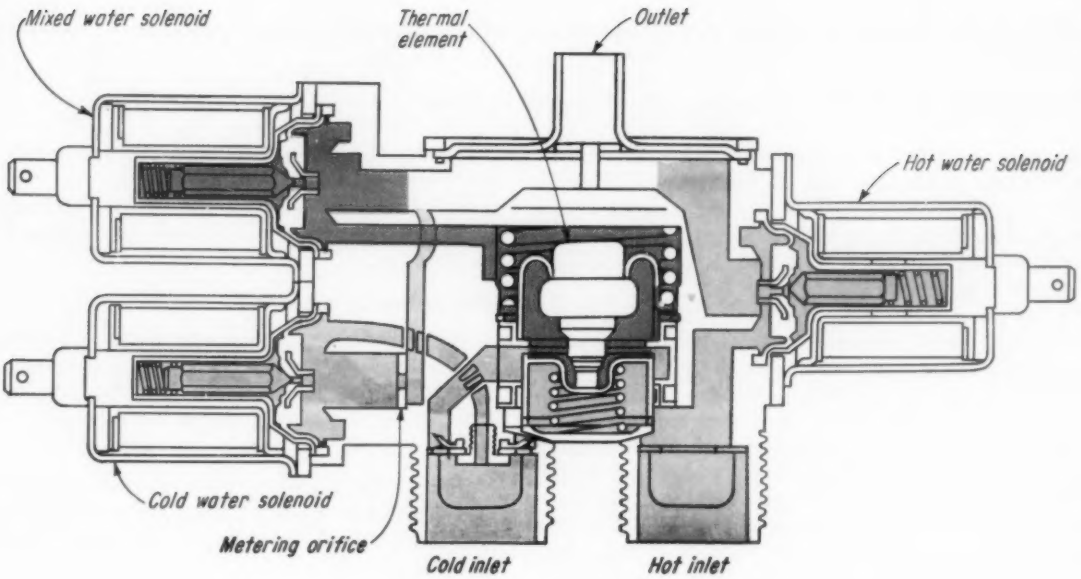
TWO MOTORS give two speeds, with no gears and only one clutch. Another clutch, which is engaged by solenoid, connects main motor to blower and pump.

During washing and part of water-extraction phase, main motor drives drum at slow speed through double reduction. Spin motor switches on for high speed. It connects to spin sheave through spin clutch, overriding large sheave and driving through single reduction. Alternate periods of high and low speed for extraction redistribute clothes so that out-of-balance system is unnecessary. (Easy Laundry Appliances Div, The Murray Corp of America, Chicago.)



CONDENSING SYSTEM for dryer of this unvented machine removes moisture that circulating air picks up from the clothes. As blower pulls hot moist air through the bulkhead, cold water is sprayed into the blower opening and broken into a mist by the whirling blades. This cools air, forcing excess water to condense. Condensate plus cooling water fall to the sump; are picked up there by the pump.

Before reheat, vanes and baffle change air direction several times to rid air of remaining water droplets. (The Maytag Co, Newton, Iowa)

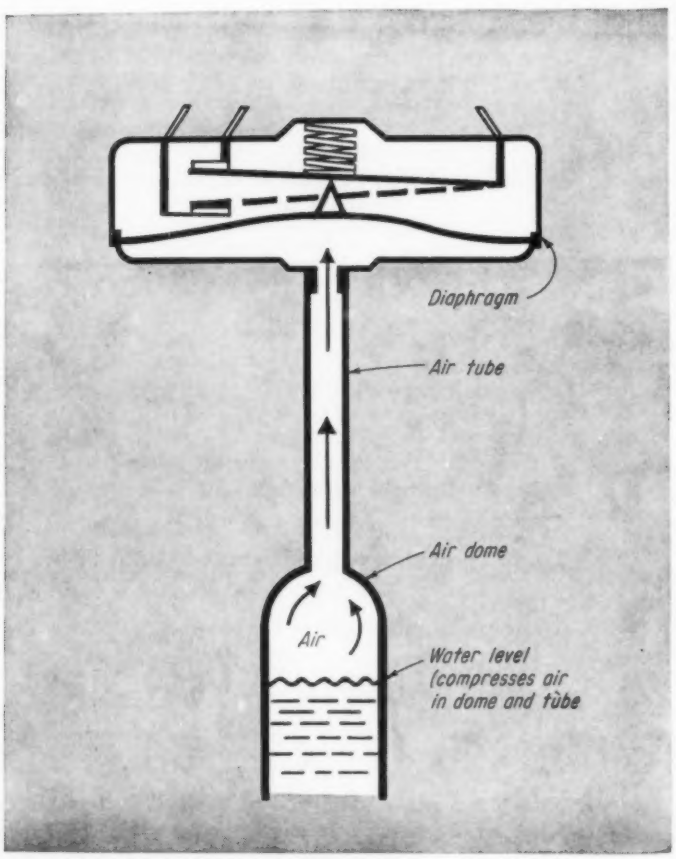


WATER-CONTROL valve supplies hot or warm water for washing and rinsing, and cold water for the condenser during drying.

Timer energizes either solenoid for hot or for mixed water at start of wash cycle and during rinse. Hot-water solenoid opens valve and allows drum to fill.

Mixed-water solenoid opens a valve downstream of the temperature control. Inside the temperature-control a thermal element expands and contracts in response to the mix temperature. As it expands, the thermal element uncovers the cold-water port and reduces the opening of the hot-water port. When the mix temperature drops, the thermal element contracts and raises the proportion of hot water, keeping the temperature 100 F, $\pm$ 5.

Cold-water solenoid energizes during drying. Metering orifice allows 0.55 gpm to pass to condenser. (Westinghouse Electric Corp, Electric Appliance Div, Mansfield, Ohio)



WATER-LEVEL SWITCH shuts off water by deenergizing solenoid valve. As water rises, it compresses air inside air tube which extends into sump. Air pressure flexes diaphragm and breaks circuit to solenoid. (The Maytag Co, Newton, Iowa)

new way FINDS NATURAL FREQUENCY of nonlinear VIBRATION ISOLATORS

You need only simple algebra and a force- deflection curve of the isolator. Author also gives a sample problem illustrating his approach.

G HAROLD KLEIN, *Ramo-Wooldridge Div, Thompson Ramo Wooldridge Inc, Canoga Park, Calif*

Here is an analytical way that gets around the usual troubles when finding the natural frequency of a unit mounted on vibration isolators. It is more accurate than customary graphic methods; it is easier and considerably cheaper than the experimental methods sometimes called on to replace the graphical approach.

The problem it solves is familiar when designing against vibration. If a unit is mounted on an isolator, its natural frequency depends not only on magnitude of its mass but also on load-deflection characteristics of the isolator itself. Most of today's isolators do not have straight-line characteristics such as simple springs would have for the same job. Instead, their load-deflection behavior is generally of the cubic or of the tangent nature. A method for calculating the natural frequency of isolators with tangent elasticity characteristics was first described by C E Crede, p 117, *ASME Transactions*, Jan '54. However, many isolators do not use elastomers in pure compression but in a combination of compression and shear, and some do not use elastomeric compounds at all. In these cases the cubic curve on next page provides a better fit to the load-deflection curve of the isolator. (In the usual graphical method of analysis, a tangent is drawn to the curve at the operating point—location of the point depends on magnitude of the mass.)

Success of the analytical method depends upon its employment of new equations. Their derivations are based on the standard frequency equations, combined with a curve-fitting analysis. With this method, one must have the load-deflection curve of the isolator to be employed. But this curve can be obtained from the manufacturer—or lacking this, the isolator can be put under a simple load-deflection test to find sufficient points for plotting the curve.

The sample problem on the facing page, analyzing a system excited by means of a steady acceleration, illustrates the method.

SYMBOLS

a	Acceleration in multiples of gravity
F	Force
f	Frequency (T^{-1})
f_n	Natural frequency of isolator (T^{-1})
g	Acceleration due to gravity (LT^{-2})
k	Spring rate (FL^{-1})
k_o	Initial spring rate of isolator (FL^{-1})
L	Length
m	Mass ($FL^{-1}T^2$)
p	Component of deflection x
q	Component of deflection x
r	Rate of increase of spring stiffness
T	Time
W	Weight (F)
x	Deflection (L)

Derivation of equations

The following cubic-elasticity equation, developed by R. D. Mindlin, "Dynamics of Package Cushioning," *Bell System Journal*, July '45, can often be fitted to curves like this one shown, and used as a starting point:

$$F = k_o x + rx^3 \tag{1}$$

The natural frequency under a steady acceleration can be calculated from the following equation taken from J. P. denHartog's book *Mechanical Vibrations*, McGraw-Hill Book Co, 1947:

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \tag{2}$$

Spring rate k is defined as slope of the load-deflection curve at the operating point, and is obtained by differentiating F with respect to x in Eq (1).

$$\frac{dF}{dx} = k = k_o + 3rx^2 \tag{3}$$

Substituting this for k gives a new equation for frequency:

$$f_n = \frac{1}{2}\sqrt{\frac{1}{m}(k_o + 3rx^2)} \tag{4}$$

Now rearrange Eq (1) as follows:

$$x^3 + \frac{k_o}{r}x - \frac{F}{r} = 0 \tag{5}$$

And solve for x:

$$x = \left(\frac{F}{2r} + \sqrt{\frac{F^2}{4r^2} + \frac{k_o^3}{27r^3}}\right)^{1/3} + \left(\frac{F}{2r} - \sqrt{\frac{F^2}{4r^2} + \frac{k_o^3}{27r^3}}\right)^{1/3} \tag{6}$$

To simplify this equation, arbitrary values p and q are assigned to the right-hand side, to give:

$$x = p + q \tag{7}$$

Under a steady acceleration, the resultant force is:

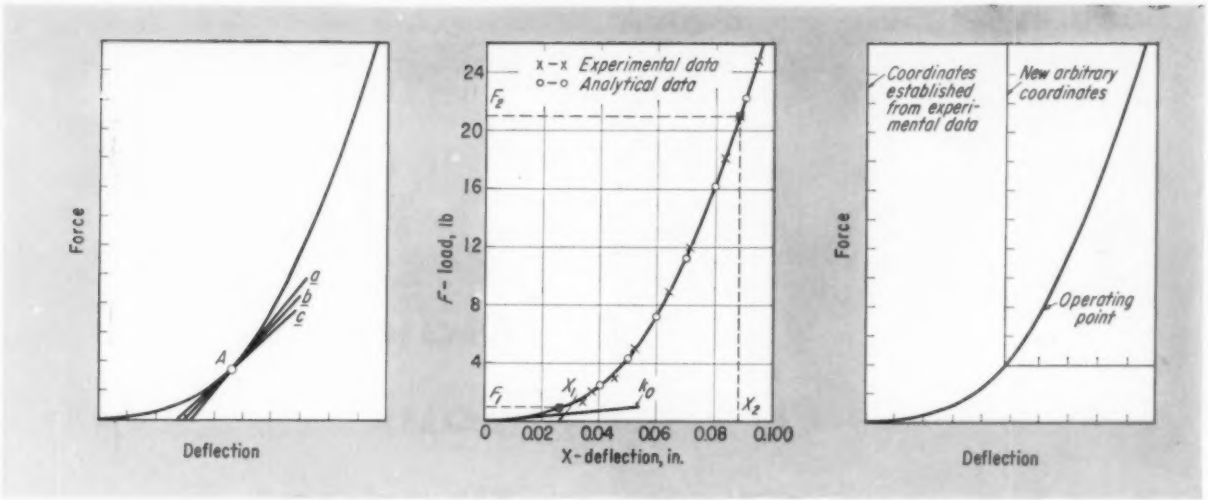
$$F = amg = aW \tag{8}$$

which can be substituted in Eq (6) to give:

$$p = \left(\frac{aW}{2r} + \sqrt{\frac{a^2W^2}{4r^2} + \frac{k_o^3}{27r^3}}\right)^{1/3}$$

$$q = \left(\frac{aW}{2r} - \sqrt{\frac{a^2W^2}{4r^2} + \frac{k_o^3}{27r^3}}\right)^{1/3} \tag{9}$$

Now that p and q, which add up to the deflection, are in terms readily available in any particular application, they



GRAPHICAL METHODS for determining slope at A could give three different results, a, b or c.

ANALYTICAL METHOD can be used to check experimental data at any point on the curve.

FINAL LOAD-DEFLECTION CURVE can be limited to operating-range portion in which the analytical and experimental data check closely.

can be substituted in the final form of the natural-frequency equation:

$$f_n = \frac{1}{2\pi}\sqrt{\frac{g}{W}\,[k_o + 3r\,(p+q)^2]} \qquad (10)$$

Example

Assuming a weight of 4 lb is to be supported on an isolator with the load-deflection curve shown above, the natural frequency under a steady acceleration of 4g can be calculated as follows.

First, pick two typical points on the curve:

$$F_1 = 1.0 \text{ and } x_1 = 0.026$$
$$F_2 = 21.0;\ x_2 = 0.88$$

Then, from Eq (1):

$$k_o = \frac{\frac{F_1}{x_1}x_2^2 - \frac{F_2}{x_2}x_1^2}{x_2^2 - x_1^2} = \frac{\frac{1}{0.026}(0.088)^2 - \frac{21}{0.088}(0.026)^2}{(0.088)^2 - (0.026)^2}$$

$$= 19.4 \text{ lb/in.}$$

Similarly, from Eq (1) calculate the rate of increase of spring stiffness:

$$r = \frac{\frac{F_2}{x_2} - \frac{F_1}{x_1}}{x_2^3 - x_1^2} = \frac{\frac{21}{0.088} - \frac{1}{0.026}}{(0.088)^2 - (0.026)^2}$$

$$= 2.84\,(10^4) \text{ lb/in.}^3$$

Substituting these values for k_o and r back in Eq (1):

$$F = 19.4\,x + 2.84\,(10^4)\,x^3$$

x in.	F lb
0.026	1.0
0.040	2.6
0.050	4.52
0.060	7.2
0.070	11.1
0.080	16.2
0.088	21.0
0.090	22.6

This is the equation that defines the load-deflection curve; it can be used to check any other points on the curve as calculated in the foregoing table for the example.

Now, p and q can be calculated from the above and the results substituted in the Eq (10):

$$f_n = \frac{1}{2\pi}\sqrt{\frac{386}{4}\,[19.4 + 3\,(2.84)\,(10^4)\,(0.0826)^2]} = 38.2 \text{ cps.}$$

Practical considerations

Natural frequencies should be determined experimentally, wherever justifiable, and checked analytically by the above method. In the operating range the analytical data should coincide closely with the experimental data. For example, in curve at right above, only the upper portion need be checked, and the final curve established with the new coordinates that include the significant operating points.

The force-deflection curve should represent true dynamic operating points. This means that if the isolator has hysteresis or friction-type damping, the applied force should be oscillating just enough to "break" the dry friction or allow the isolator to "settle" to its true operating position. This also applies to any graphical method for approximating slope of the curve.

Graphical methods could be used to check the analytical methods, and minimize the number of points to be calculated.

The equations derived here are applicable for cases with steady acceleration, expressed in multiples of gravity; but if acceleration a = 1 in the equations (9), it is possible to use them to calculate the natural frequency of any nonlinear isolator exhibiting the cubic-elasticity characteristics, regardless of its application.

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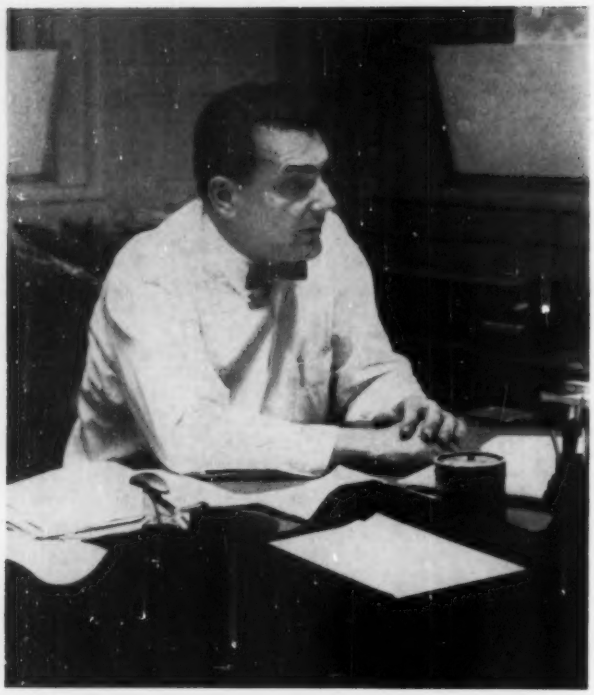


Make your Product Tests USER TESTS

Says Morris Kaplan, technical director of Consumers Union, in an interview with Product Engineering. It is the only way to find out how successful your design really is.

In a 6500-sq-ft laboratory on the third floor of a converted optical factory, an engineer stands near a section of rug and moves a vacuum cleaner in a repetitive back-and-forth pattern not much different from the way any housewife might.

A few feet away, a technician drops a load of laundry into a washing machine and pushes the button that starts up the automatic cycle.

One floor below, an engineer examines the innards of several dozen dismantled steam irons, assessing the corrosion damage that exhaustive ironing tests over the past month may have produced.

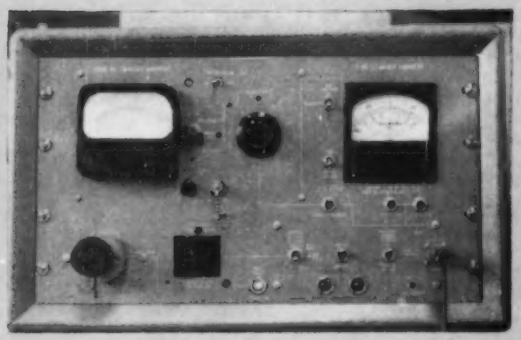
This is Consumers Union, an organization dedicated to the idea that one of the best ways to find out whether a product is any good is to use it—under carefully controlled conditions, but in as close a duplicate of the way it will be used by the consumer as possible. They are convinced that laboratory tests are too often assumed to have a direct relationship to use values; an assumption which they say is naive and, what's worse, unrealistic. They deplore the fact that too often neither manufacturers nor government agencies take the time, trouble and responsibility to study a product or industry and come up with test procedures having proved ability to discriminate realistically between good and bad products. Let's hear CU's technical director, Morris Kaplan, explain methods and goals of his testing setup. Says Kaplan:

Your customer doesn't buy components or even engineering specifications, he buys a function—clean clothes, clean rugs, transportation, music or television entertainment in his living room. So any formal evaluation testing that omits the user is likely to be unrealistic. Yes, we frequently make use of standard laboratory tests, and they often provide useful information, but we don't deceive ourselves that the results are at all comparable to data drawn from user experience.

Ideally we prefer a laboratory test which has a known correlation with user experience. To get this you start with a use test. At the same time you dream up likely looking laboratory tests and apply them to the same products. Then you correlate the results, discarding lab procedures that offer no useful correlation, until you come up with a fast, accurate lab test that provides, ideally, a simple number—along a scale that accurately represents some measure of user value.

It isn't an easy procedure—and after 25 years of testing,

The Ideal Test Instrument—I



To measure shock hazard . . .

■ Only repeated tests with human beings can tell how dangerous a shock hazard is. Original research by Charles F Dalziel, at the Univ of California, on human reactions to electric currents provided the scientific basis for this CU-designed device. The instrument measures leakage current to either side of the power line from exposed conductive parts on an appliance. Human reaction to electric current has been established as directly related to half-amplitude ac current (peak values). Thus either a special meter or an oscilloscope may be used. To get a number, representing hazard, Consumers Union chose a meter for the majority of such determinations.

The instrument is, in essence, a modified vacuum-tube voltmeter reading voltage drop across a load. The voltage has a direct relationship to current drain and the dial has been so calibrated. The circuit consists of a 1500 ohm resistive load (representing body resistance) plus a capacitor in parallel chosen so as to attenuate the response at the higher frequencies in proportion to the body's sensitivity to higher frequencies (the body is less vulnerable to higher frequencies). Says Monte Florman, head of the appliance division, "We classify as 'acceptable' less than 0.1 milliamps between exposed metal surfaces and either side of the power line. We classify 0.1 up to 1.0 ma as acceptable but downgraded somewhat. The 1 to 5 ma range may pass or fail depending on the product and its application in normal use. Over 5 ma is always unacceptable."

The instrument has several embellishments: it can read dc components of the current (right dial), negative or positive half-wave amplitudes or peak-to-peak (left dial), it has a built-in calibrating zener diode for frequent checks on the stability (very important at these low current levels).

This whole problem of appliance shock hazard is a lot more complicated than Underwriters' Laboratories standards may imply. This instrument provides a number which is a pretty good guide to the danger in a particular situation, but the device cannot know how many "grounds" there may be in any given location in a home nor can it evaluate the likelihood of, say, a wire breaking loose and contacting the housing of, say, a metal TV cabinet.

[For more information on the problem of shock hazard in general, and for detailed information on the design of the instrument, write Morris Kaplan, Technical Director, Consumers Union, 256 Washington St, Mt Vernon, NY.] ■

Consumers Union has only found a few lab procedures that approach this ideal (see boxes, above and page 59).

Vacuuming rugs

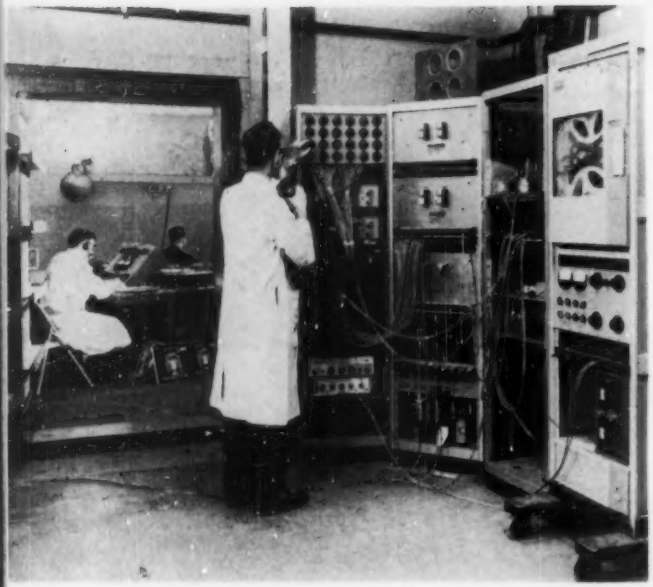
How would you determine the cleaning ability of a vacuum cleaner? An engineer might measure the suction pressure and volume of air moved. While these are important considerations, what guarantees are there that these characteristics really measure cleaning ability? Further—choice of the one with highest suction pressure and greatest volume doesn't necessarily mean that that cleaner is better than the one with next lowest pressure or volume.

If you accept our philosophy you will test your vacuum cleaner on a rug. But is it to be an artificially soiled rug (on which has been spread a standard paste of coal dust, sand and loam) or a naturally soiled one—walked on by people, dogs, and little boys' knees?

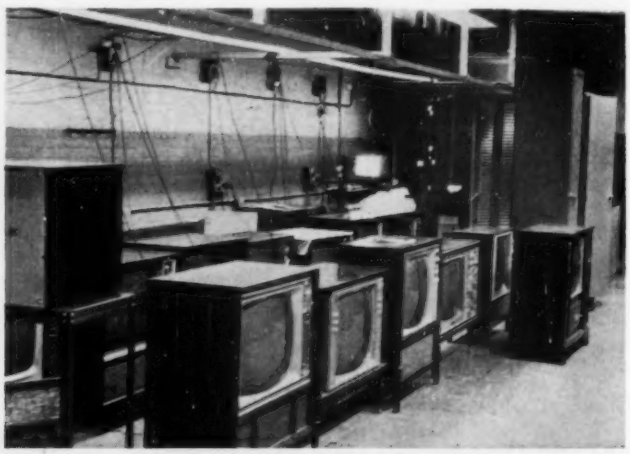
See the problem? How realistic must the test be? The industry doesn't seem to be able to make up its mind, and all too frequently individual manufacturers won't spend the money to find out.

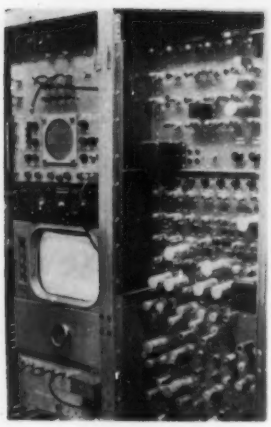
So, as of now, there is no generally accepted, validated method. We naturally think our system (see photo) is

VACUUM CLEANER TEST PROCEDURE alternates tested cleaner with one chosen as a standard for fixed time intervals. Engineer moves cleaner head at same speed as marker taped to pulley-driven belt running along frame. After each cleaning cycle the dust bags are weighed and recorded results provide graphic plot of rate of soil pickup.



HIGH-FIDELITY LISTENING ROOM, walled with sand-filled high-density concrete block, has double door stiffened with I-beams. When both doors are closed, air is evacuated from trapped space between doors to make a near-perfect sound barrier. Room is thus almost completely isolated from outside noise. It has draw drapes on all walls to help control reverberation, scrim cloth in front of speaker bay to eliminate influence of speaker appearance on judgment of sound quality. Tape recorder had to be better than best commercially available test instruments. It is a modified Ampex instrument tape transport with Consumers Union-designed electronics.





TELEVISION SETS all receive the same test pattern for comparison. Closed-circuit setup includes camera, back-lit interchangeable test pattern, monitor screen, and individual signal boosters at each test station (high on wall in left background).

best, but another method would be taken up in a minute if it showed better qualified results.

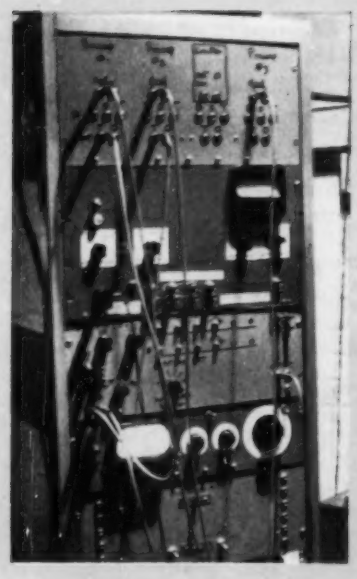
And detergents

Again, here's an area without standard tests that have proved satisfactory. Nor have detergent manufacturers (relatively large in size and with substantial resources) settled on a completely acceptable and realistic standard test procedure.

What method is right? We decided to go to the user with the general-purpose detergents tested this winter. We took samples, repackaged them in coded containers, and sent them, two to a customer, to several hundred women. We included mimeographed copies of the manufacturers' directions on how the detergents were to be used and told the women, in effect, "If you're washing walls today, or blinds, or floors, or whatever, try this instead of what you usually use." We followed this with a detailed questionnaire—the results were published in *Consumers Reports* this January.

Why couldn't the manufacturers themselves have done this? The answer is they could (and maybe they have). Actually, a service department and a sales department can feed back exactly the same kind of information to the designers. In this sense the manufacturer is in a much better position than a formal test organization could ever be. The independent testing agency starts relatively cold—no information, no knowledge other than that available in the literature and in its background and experience. The manufacturer often has hundreds of channels

The Ideal Test Instrument—II

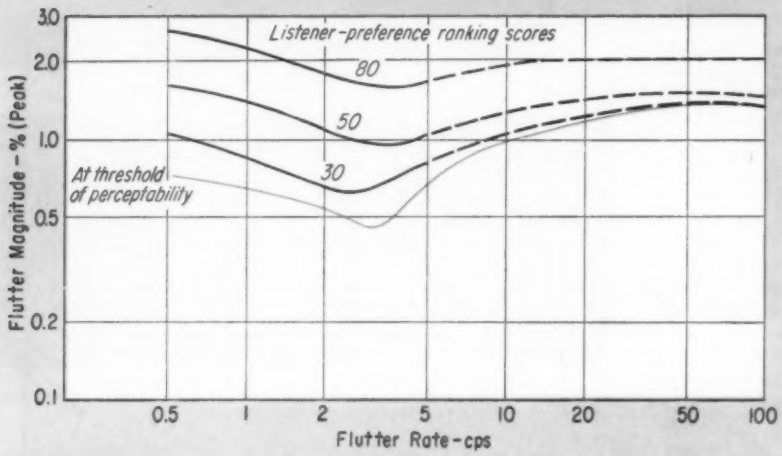


To measure hi-fi flutter

■ Flutter or "wow" is speed variation in the drive of a high-fidelity turntable or tape recorder. No mechanical drive can be absolutely constant, so a designer must establish a minimum standard for his product. The manufacturer's engineers (or the advertising copywriters) assume that the percentage variation in drive speed is enough to give the answer, but they don't *know*.

Frank A Comerci of the Material Laboratory of the Navy Dept. Bureau of Ships did a whole series of listener preference tests and came up with some interesting figures. (See *Society of Motion Picture and Television Engineers Journal*—March 1955 and August 1956). As the graph here shows, people are not only conscious of speed variation—they are sensitive to the frequency of speed variation as well. The color line shows the threshold of awareness of flutter (for piano) with an especial sensitivity at 3 cps. As greater percentages of speed variation appear, people are successively more aware (and annoyed)—through scores of 30, 50 and 80—to a listener's saturation level at 100 (any higher percentages of flutter are no more obnoxious than the 100 level).

This graph provides the test engineer with a number directly related to user experience. It may be used as is or, as Comerci and later CU did, built into a laboratory instrument (see photo) which includes a weighting network, a VU meter with rms-responding movement and all. You pipe the output of a record player into the instrument and read a listener awareness score on the meter. Says Larry Seligson, a CU Project Supervisor, "0 up to 5 on the meter is practically undetectable to human ears, 5 to 8 is still good, 11 to 15 is fair, over 15 is not recommended for any system pretending to be a high-fidelity rig." ■



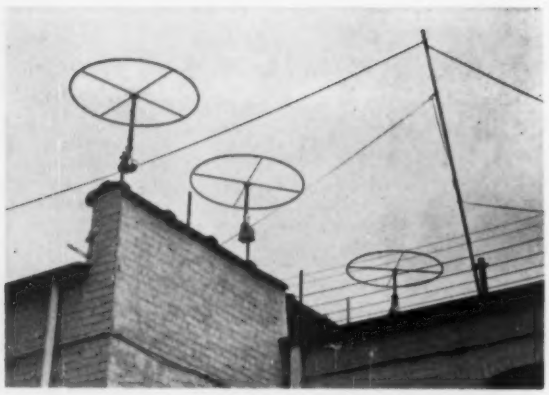
of information at his command. The record of past sales and past experiences should be invaluable aids in the design of a new model or the application of a familiar component to a new product.

But how much effort do companies make to collect and use this information? Apparently not enough, as a rule—and, in companies where models change annually, the new models are being designed before the old ones have been in the field long enough to provide any useful information. So the designer relies on his instincts and experience and the dictates of the sales manager.

And then, of course, mistakes are made—even by the best of designers. Sometimes the mistakes are obvious once the product is put together; other times the mistakes are more difficult to find, especially when durability is involved. (Durability is the one phase of testing where we have the most difficulty. In one case CU recommended a product in which a single component tended to fail after several months of use. Neither manufacturer nor CU discovered this because the life tests did not simulate *all* the conditions of use encountered in actual field circumstances. We were both considerably embarrassed.)

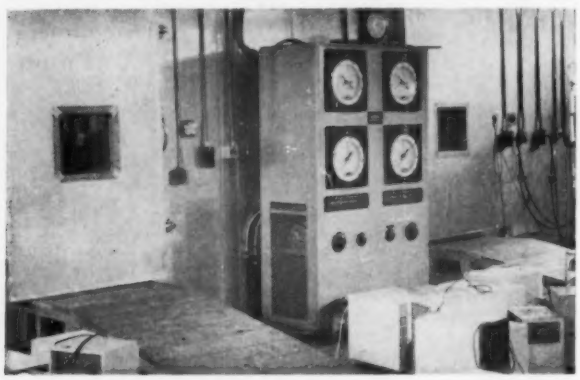
When errors of this kind do occur the manufacturer may try to make good on the losses—at the cost of hefty sums of money, money that might better have been spent exhaustively pretesting the product, or better yet, establishing test procedures that would reveal such flaws quickly and inexpensively.

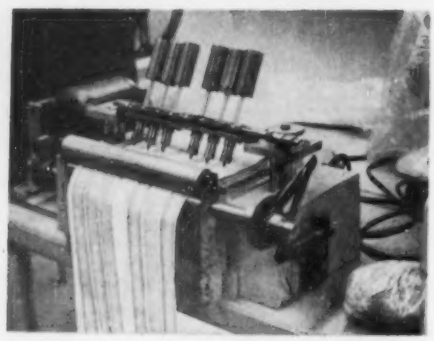
Research in test methods is expensive—and who is to do it? Individual manufacturers? Industry associations? Con-



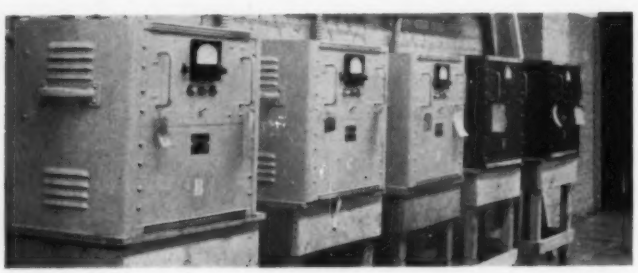
ANTENNA ROTATORS are tested with a ring having approximately the same moment of inertia as the standard antenna. The controllers, in the TV lab below, are cycled regularly by a timed motor drive unit.

CONTROLLED ATMOSPHERE ROOM is really two rooms with a collapsible partition. Each has separate temperature controls which permit flexibility in test operations.





BALLPOINT PENS are weighted and pressed against a continuously driven strip of paper. Pens move in a narrow oval. Side-by-side strips of writing are easily evaluated by eye.



INDIVIDUAL VOLTAGE REGULATORS provide controlled voltage for appliance testing. How does a washing machine or vacuum cleaner operate at 105 v, or 125 v? There's only one way to find out.

sumers? Universities? Government? All have done some work in this direction but the most objective and knowledgeable would probably be industry groups or government. I believe research in test methods by the government to be the most feasible.

No honest manufacturer can be hurt by a yardstick against which he (and the consumer) can measure the quality of his output. In many respects the development of good methods for evaluation of a product is similar to the development of standards of length, mass and time which is now the function of the Bureau of Standards. Why should not NBS, with its great understanding of measuring problems, of materials of technology and of testing techniques, as representatives of us all, producer and consumer alike, undertake to develop and publish methods of product evaluation for anyone to use in the best interest of the whole country?

While many Bureau people do participate in the work of ASTM, ASA, and other organizations which concern themselves with standards and test methods, the test methods these organizations work on generally apply to *materials*, not ultimate consumer goods. And it is in this methodology of evaluating ultimate consumer goods that the major problems exist for most of us. Improving the method for determining the tensile strength of a bar of plastic may be a worthy endeavor. But it does not necessarily tell us how to determine which of several plastic members will be best for a particular building use.

Perhaps, in addition, some university people would find this work challenging. It is a field in which the ground is barely broken. It cuts across many disciplines; it can challenge the imagination of architects, engineers, psychologists, statisticians, chemists, physicists, etc. It should produce support not only from the universities, but from the foundations, from government (which does a lot of purchasing and could use such information), from industry and labor groups and most assuredly—as the consumer movement grows—from consumer groups. ■

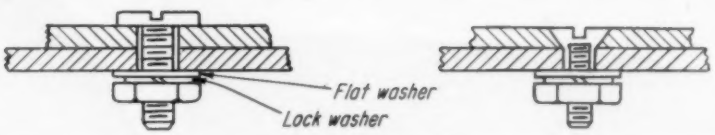
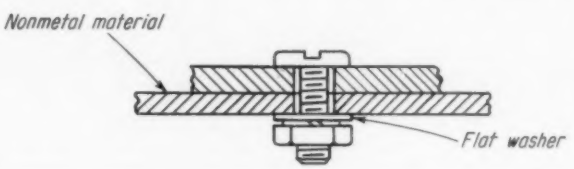
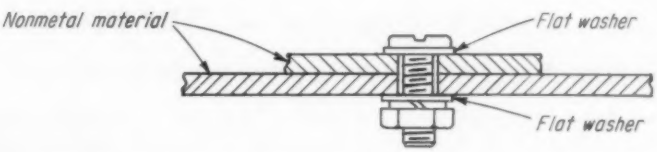
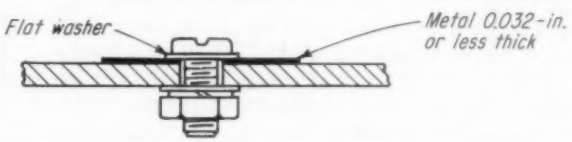
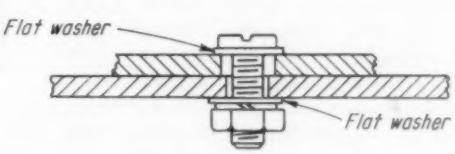
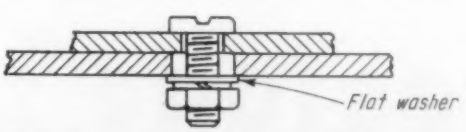
6 APPLICATIONS FOR FLAT WASHERS

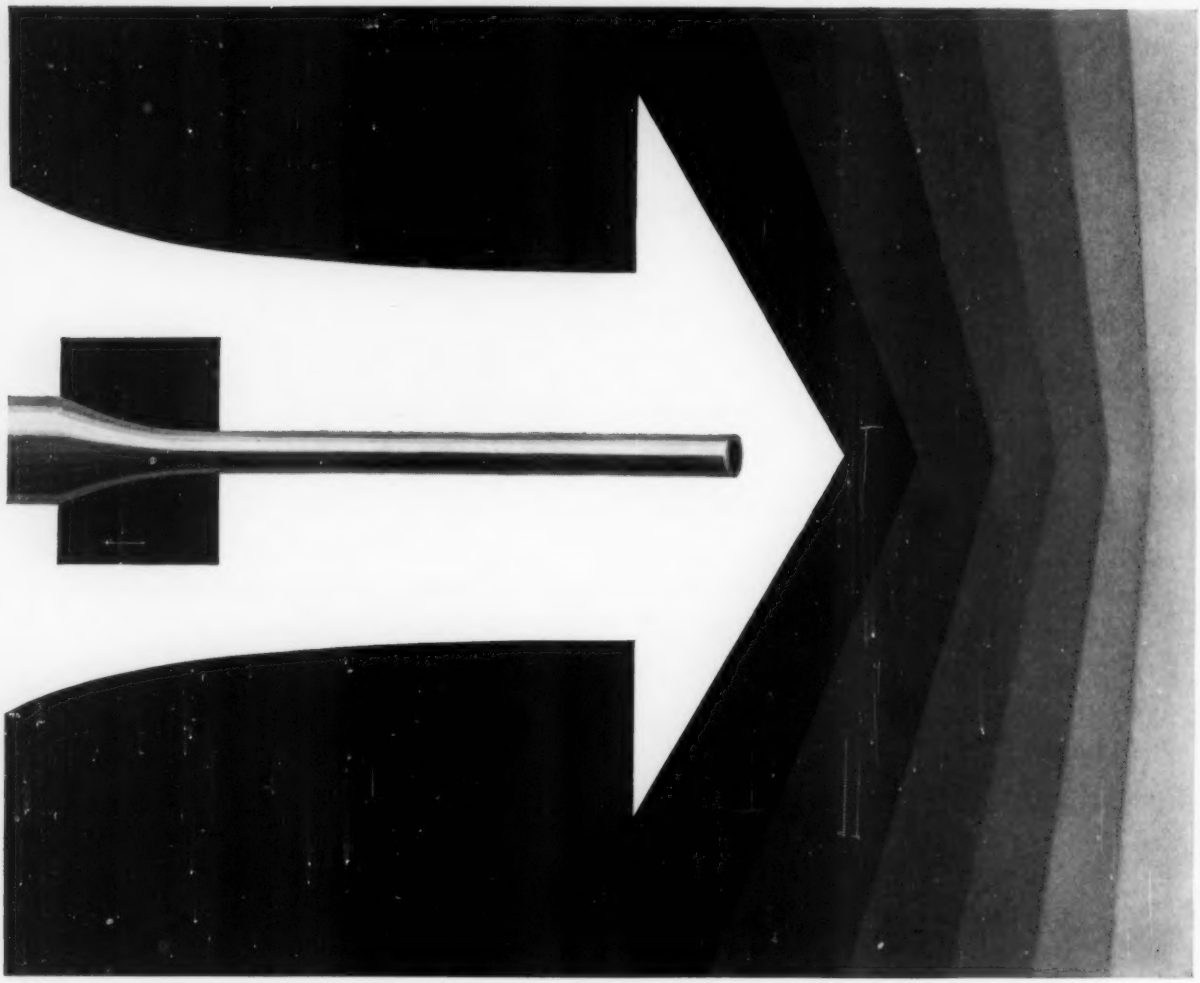
N DALE LONG
Supervisor, Vitro Laboratories
Silver Spring, Md

When a split lockwasher is called for in a screw fastening, a flat washer is invariably necessary. The ways of assembling them illustrated below are strict requirements in military specifications—especially for electronic equipment. Commercial requirements usually vary—depending upon either the designer's decision or product-cost restrictions. For good quality and reliable service, however, the fastening methods shown here can be depended on to pay off.

ASSEMBLY OF FLAT WASHERS AND SPLIT LOCKWASHERS

Flat washers should be placed between . . .

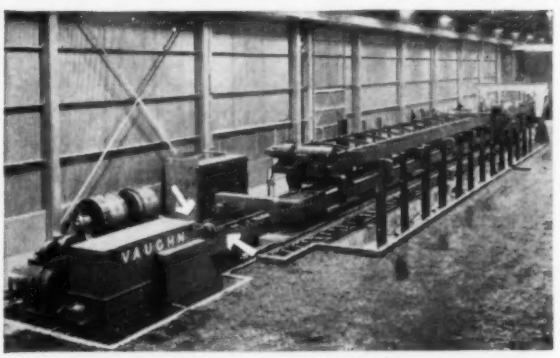
1 Metal surface, whether finished or not, and locking washer	
2 Nonmetal surface and locking washer	
3 Screw head and nonmetal surface	
4 Screw head and metal that is 0.032 in. or less thick	
5 Screw head and enlarged or elongated clearance hole	
6 Locking washer and enlarged or elongated clearance hole	



How to shock-insure a $250,000 tubing drawbench

Firestone Airmount® impact protection saves drawbench-carriage damage and downtime

Shortly after The Vaughn Machinery Company, Cuyahoga Falls, Ohio, installed a high speed dual chain drawbench for the Reynolds Metals Company, the limit switches failed to stop the carriage within the confines of the bench. It slammed into the drive section at full speed, about 550 fpm (with a kinetic energy of almost 1,500,000 pound-inches). Not only could this have caused many thousands of dollars of damage, but downtime would have been measured in *months*. Instead, damage was negligible, downtime almost non-existent. Why? Three Firestone Airmounts were stationed on the drive-head to gently absorb the impact. Valuable "insurance" indeed! And that's just one of thousands of profitable examples of how Airmounts are solving motion problems throughout industry. Whatever your equipment, if it produces damaging shock or vibration—or if it needs help for actuation—find out how much Airmounts can do for so little. Write to Dept. 41-1 for details, without obligation.



Here is the huge Vaughn dual chain drawbench at the Reynolds Metals plant in Phoenix, Arizona. Note Firestone Airmounts positioned at head of drive section, protecting against possible impact of carriage.

Tune in Eyewitness to History every Friday evening, CBS Television Network

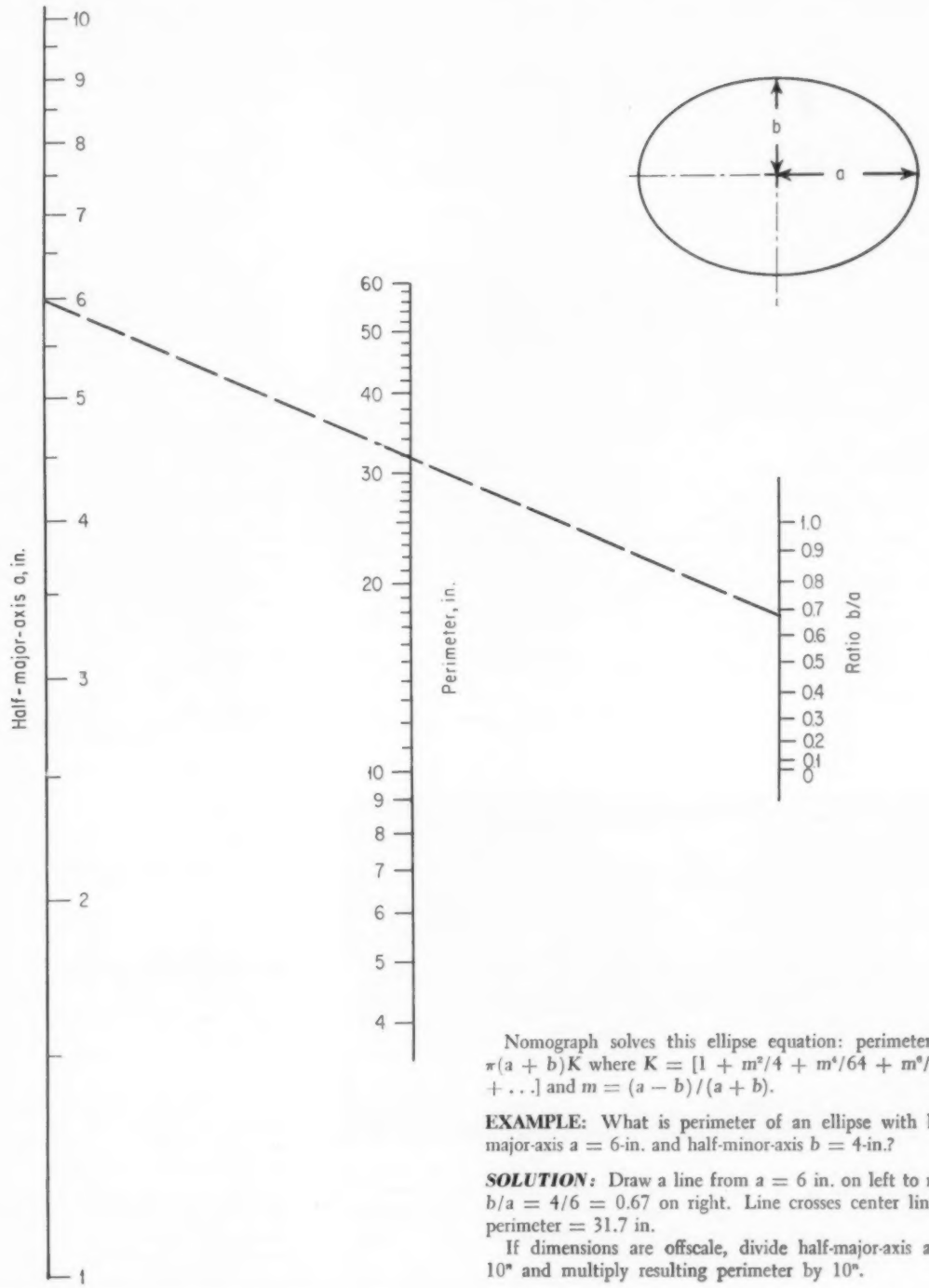
Firestone

AIRMOUNT® FOR INDUSTRY

Firestone Industrial Products Co., Noblesville, Indiana

CHART FINDS PERIMETER OF ELLIPSE

ROBERT L PETERS
Consultant, San Francisco



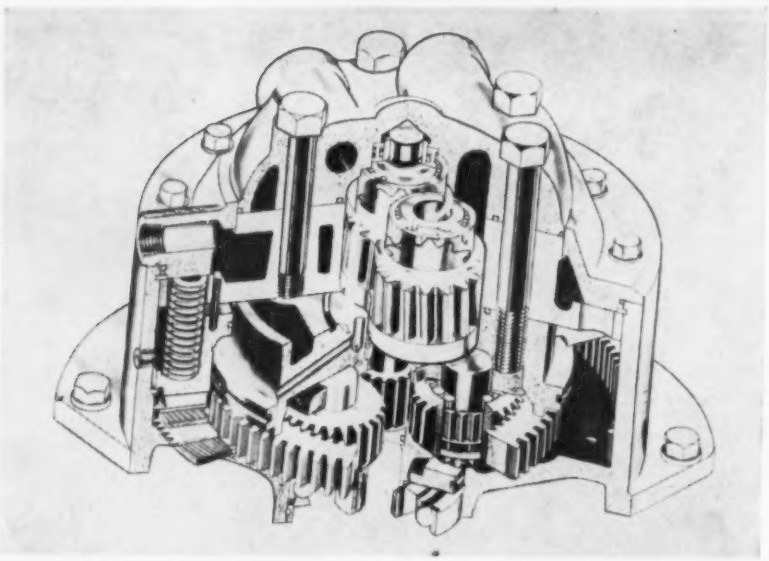
Nomograph solves this ellipse equation: perimeter = $\pi(a + b)K$ where $K = [1 + m^2/4 + m^4/64 + m^6/256 + \ldots]$ and $m = (a - b)/(a + b)$.

EXAMPLE: What is perimeter of an ellipse with half-major-axis $a = 6$-in. and half-minor-axis $b = 4$-in.?

SOLUTION: Draw a line from $a = 6$ in. on left to ratio $b/a = 4/6 = 0.67$ on right. Line crosses center line at perimeter = 31.7 in.

If dimensions are offscale, divide half-major-axis a by 10^n and multiply resulting perimeter by 10^n.

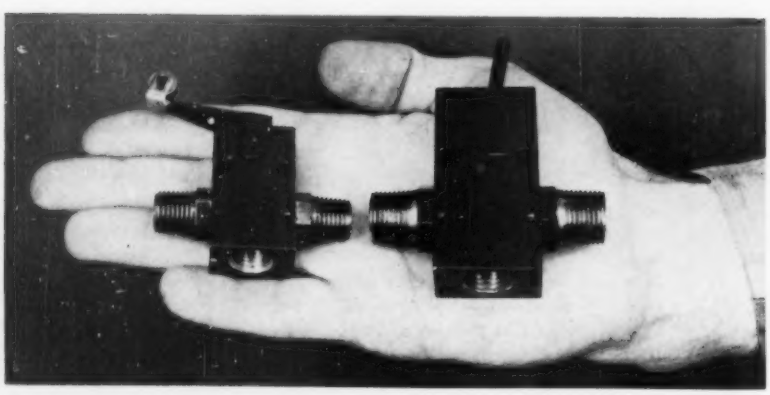
SIGNIFICANT COMPONENTS MATERIALS, PROCESSES



Hydraulic gearhead motors . . .

are available in three sizes and six reduction ratios, and can be supplied with same speed in both rotations or with high-speed reverse, which produces 0 to 5¼ times forward speed. Each has metering valve which operates in both rotations, enabling operator to "inch" heavy loads under complete control. Any loss of pressure instantly sets brake to prevent load taking charge. Max output speed of the three models at full load are 362, 257 and 210 rpm. Max output torque in forward is 2020, 4870 and 11,500 in.-lb, respectively; in reverse, 388, 870 and 2156 in.-lb, respectively. Prices: $525, $750 and $1250 plus duty and brokerage. Delivery from stock on small quantities; 30 to 60 days on larger orders. **Gearmatic Co Ltd, 7500 132nd St, North Surrey, British Columbia.**

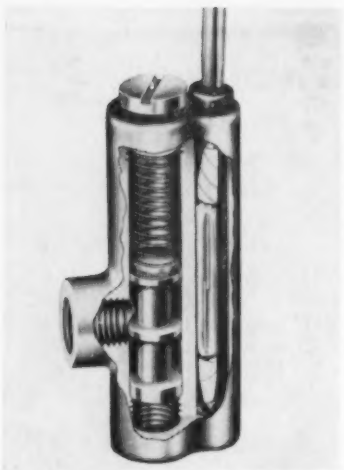
Circle 300 on Reader Service Card



Three-way valves . . .

for operating pressures up to 100 psi, have turning male pipe connections which permit installation without unions. Two or more can be manifolded for multiple operation. Available in a wide range of orifice sizes, materials and operator types. **Instruments Inc, PO Box 556, Tulsa, Okla.**

Circle 301 on Reader Service Card



Less than ½-psi differential displaces . . .

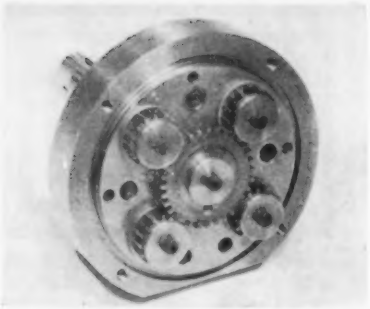
flow switch's magnet-equipped piston. Permanent magnet, in turn, actuates hermetically sealed switch contacts to operate remote warning light or other indicator. Acting on present flow rate, unit is designed to detect flow or lack of it in small circulating systems. Can be factory-set between 5 and 50 gph, but in many cases is used on lower setting to indicate decrease in oil flow. Standard model's ambient temperature ranges from −20 to 200 F, while switch contact ratings are 6, 12, 28 v dc or 115 to 230 v, 60 c ac. Unit's ¼-in. NPT ports fit standard piping. Prices range from $30 each in quantities of 1 through 4, to $18 each in quantities of 200 through 299. Delivery within 2 wk. **Gems Co, Sheppard Lane, Farmington, Conn.**

Circle 302 on Reader Service Card

Dc static timing relay . . .

has operating voltage of 48, 125 or 250 v dc for directional-distance relaying. Provides timing from a dc source with $\frac{1}{10}$ to 3-sec accuracy. All-static circuit gives relay over-all accuracy of ±3% of setting within following limits: supply-voltage variation of −20 to 10% of normal battery voltage; ambient-temperature changes of −20 to 104 F; and rms value of ac ripple, 7% of applied dc voltage or less. For ambient temperatures of 158 F, accuracy is within ±5%. **Westinghouse Electric Corp, PO Box 2099, Pittsburgh 30.**

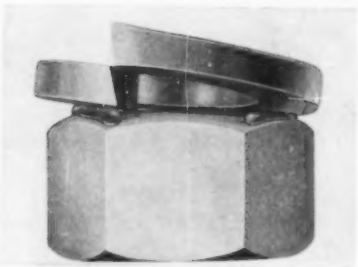
Circle 303 on Reader Service Card



Rotating-vane hydraulic motor

for accurate control at all speeds, reportedly provides nearly 100% torque at stall and infinitely variable speed. Constant-displacement-type unit, suitable as a servomotor, can be connected directly to such loads as machine-tool lead screws without intermediate gear reduction. Has dual-vane rotor and timed-interval valving. Available in three sizes with displacements ranging from 2.2 to 7.6 cu in. per revolution. Torque ranges from 35 to 121 in.-lb per 100 psi; hp output, from 15 to 41.5. Speeds are up to 1500 rpm and max pressure, 2000 psi. Diameters are from 5⅛ to 7⅛ in. Price: $290 to $1000. Delivery: from stock or 4 to 5 wk. **Hartmann Mfg Co, 1637 Goold St, Racine, Wis.**

Circle 304 on Reader Service Card



Preassembled nut and washer . . .

consists of standard hex nut joined with standard helical-spring lockwasher by means of special adhesive. Counteracts any looseness caused by tension loss in assembled parts. Available in $\frac{1}{16}$- and $\frac{3}{8}$-in. sizes, fine and coarse threads, plain and plated finishes. **Philadelphia Steel & Wire Corp, Penn St & Belfield Ave, Philadelphia 44.**

Circle 305 on Reader Service Card

Precision flexible coupling . . .

is a one-piece unit that permits linear and angular misalignments without angular backlash and at the same time allows parallel hub displacement and hub-bore concentricity of 0.001 in. TIR. Originally designed for missile-control instrumentation, it is suitable for servogear trains, computer mechanisms and other rotating precision devices. Said to overcome excessive side thrusts created by other couplings rotating over 360°. Recommended max linear misalignment is 0.10 in.; angular misalignment, 2°. Max torque rating is 10 oz-in. Hub-bore diameter is held to within 0.0003 in. From stock. **Santa Fe Instruments Inc, 2343 Jerome Ave, New York 68.**

Circle 306 on Reader Service Card

Static air-pressure clutch . . .

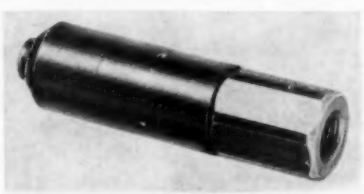
mounts anywhere on shaft or motor. Self-adjusting unit, for applications up to 10 hp, is both clutch and motor sheave. Said to provide shockless starts without overheating. Hooks up with V-belts or pilot mount for special sheaves and sprockets. **Horton Mfg Co Inc, 1179 15th Ave SE, Minneapolis 14.**

Circle 307 on Reader Service Card

High-power solenoid . . .

incorporates a coil with two windings. One is a high-surge, pull-in winding which starts solenoid plunger in motion. Second is a low-drain winding for holding plunger in a seated position. Windings are switched automatically by plunger motion. Rated for continuous-duty service. **Anderson Controls Inc, 9959 Pacific Ave, Franklin Park, Ill.**

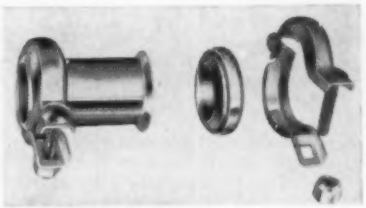
Circle 308 on Reader Service Card



Recycling poppet valve . . .

Automatically and completely eliminates static air pressure from pilot chamber of bleeder-type air-operated valves. Pressing of plunger opens poppet at bottom of valve. Poppet remains unseated until all static air is released and then reseats while plunger remains depressed. Four-way valve can be actuated in opposite direction even though poppet valve plunger is still depressed. **Novi-matic Valve Div, Novi Tool & Machine Co, Novi, Mich.**

Circle 309 on Reader Service Card



Pipe coupling . . .

available in standard pipe sizes from $\frac{3}{4}$ to 4 in. and in lengths from 2 to 36 in., allows up to 4° angular misalignment and permits both angular and axial pipe movement without leakage. Fully contained gasket is said to assure uniform pressure against pipe and sleeve without extrusion in any area. Fastens with only one nut and bolt on each coupling end, making it suitable for quick-breakaway connections. Reportedly meets ASA requirements for 150-lb service with temperatures from —40 to 250 F. **Marman Div, Aeroquip Corp, 11214 Exposition Blvd, Los Angeles 64.**

Circle 310 on Reader Service Card

Air-hydraulic toggle clamps

have over-center toggle locks that eliminate bounce or recoil and can be used individually, in series, sequentially or simultaneously. Holding pressures are up to 450 lb at 80-lb line pressure. Three models each weigh 1 lb, 10 oz and provide 350-lb clamping pressure, 150 psi air pressure and 250 psi oil pressure. Double-acting cylinders have $1\frac{1}{8}$-in. bores and $1\frac{7}{8}$-in. strokes. **Detroit Stamping Co,330 Midland Ave, Detroit 3.**

Circle 311 on Reader Service Card

Rotating mirror . . .

modulates light beam in photoelectric protective unit. Neither variations in normal ambient light conditions or substitute light affect the beam. Unit consists of wide-beam projector, wide-beam photoelectric receiver and control device. Standard "curtains" are 7, 12 and 17 in. wide. Projector and receiver can be mounted on press or other machine any distance apart up to 15 ft. Control device operates when 2 in. or more of the light curtain is obstructed. Stops machine operation automatically when any part of a person's body enters the danger area. For semiautomatic press operation, light curtain can serve both as protective device and to increase production with manual

continued on page 66

Ed Johnson, Furnace Application Engineer, talks about

SINTERING CERMETS

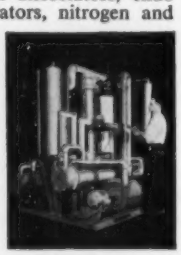
Whether you're working with cermets, ceramics, refractory metals, or stainless steel powder compacts, Hayes has the *right* furnace and the *right* atmosphere to give you best results at lowest cost.

PRECISE SINTERING TEMPERATURES are important for effective bonding of compacts. The Hayes Type M-Y High-Temperature Furnace provides the exact, uniform heating required — has straight-through design for easy operation.

ECONOMICAL, TOO, the Hayes Type M-Y furnace needs only modest power input for temperatures to 3300°F with Moly elements. It can be used with reducing atmospheres for close control research or full-scale production, and is available with metallic or ceramic superhearths.

HIGH-SPEED HEATING and cooling cycles mean big production with the Hayes Model HT/HV Vacuum Furnace. A full-production size vacuum furnace, this Hayes unit is cold-wall designed for compactness as well as operating comfort. Heat-up to 3000°F range and over in minutes, with low voltage elements. High vacuum to 0.1 micron . . . low leak rate.

THE RIGHT ATMOSPHERE is available from the complete Hayes line —ammonia dissociators, endo and exo generators, nitrogen and forming gas generators, gas dryers — all designed for controlled, dependable operation.



WHATEVER YOUR SINTERING PROBLEM — for production, high temperature or research sintering, Hayes know-how and equipment can supply you with a Results Guaranteed answer . . . tested in our lab on shop-scale equipment, and proved by scores of similar installations in industry. Write for bulletins on Hayes sintering furnaces. C. I. Hayes, Inc., 958 Wellington Ave., Cranston 10, R.I.

C. I. HAYES, INC.

Established 1905

It pays to see Hayes for metallurgical guidance, lab. facilities, furnaces, atmosphere generators, gas and liquid dryers, Pow-R-Trol (TM) control units.

feed. Protects operator on downstroke and allows removal and placement of parts on upstroke. **Clark Controller Co, 1146 E 152nd St, Cleveland 10.**

Circle 312 on Reader Service Card

Organosol coatings . . .

adhere to metal with only one application and no primer. Said to be more abrasion-resistant than coatings requiring two applications and priming. One-coat organosols are vinyl-resin based and can be applied by manual, automatic or electrostatic spray equipment as well as by regular and reverse roll-coaters. Baking cycles are flexible. **Bradley & Vrooman Co, 2629 S Dearborn St, Chicago 16.**

Circle 313 on Reader Service Card

PVC ball valves . . .

are available in ¼ to 3-in. sizes. Provides positive shutoff at pressures to 125 psi with ¼ turn of snap-on handle. Useable at temperatures to 140 F, they are made of unplasticised Type I polyvinyl chloride with tensile strength of 8500 psi. Coupling-like assembly permits each half of valve to be fitted to pipe ends and then reassembled. **Hoke Inc, 1 Tenakill Park, Cresskill, NJ.**

Circle 314 on Reader Service Card

Miniature servomotor . . .

measuring ½-in. dia and 0.968 in. long and weighing 0.68 oz, is designed for servosystems where instant response is required. Speed at no load is 9500 rpm; stall torque, 0.12 in.-oz; operating temperatures, from —66 to 257 F. Power input at stall is 1.7 w; frequency, 400 cps; and voltage, 26 v. **Kearfott Div, General Precision Inc, 1180 McBride Ave, Little Falls, NJ.**

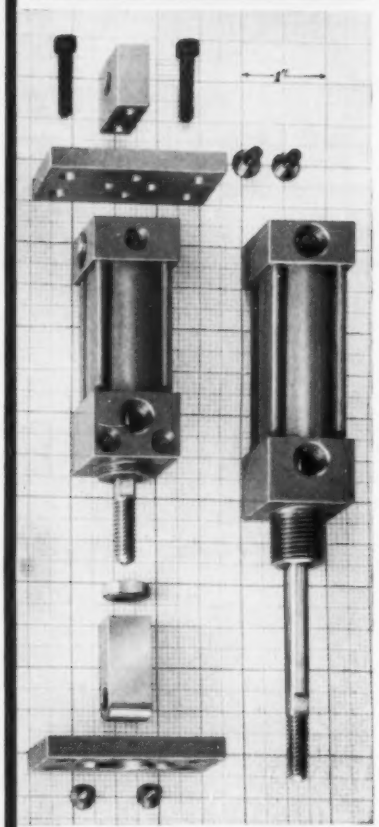
Circle 315 on Reader Service Card

Freewheeling ballbearing screw . . .

limits nut travel at predetermined positions and permits continuous rotation of screw. Has stop at each end of desired nut travel and freewheeling device as integral part of nut assembly. Eliminates need for limit switches or other devices to limit travel and prevent jamming or stalling. Load-carrying capacities are said

continued on page 69

HOW SMALL do you want 'em?



Hannifin offers new "Midget-Air" 200 psi cylinders in ¾", 1" and 1⅛" bores, double-acting or spring-return. Two basic models, "universal" and "nose-mounting." Universal models come drilled and tapped for mounting, or for use with any combination of the mounting attachments pictured. Delivery is off-shelf in standard strokes, shipment in ten days to specified stroke lengths. Want dimensions and prices? Write:

PARKER HANNIFIN CORPORATION
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

HANNIFIN COMPANY
A DIVISION
525 South Wolf Road
• Des Plaines, Illinois

8290-PH

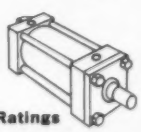
EUROPEAN DIVISION • PARKER-HANNIFIN N.V.
SCHIPHOL • THE NETHERLANDS

THIS . . . IS WHAT YOU BUY!

POWER — clean, dry, drip-free power at the business end of a Hannifin piston rod is the result of Hannifin extra quality, and at no extra cost. Bores are honed to 15 RMS or finer . . . piston rods are case hardened, plated and polished to 10 RMS or better. Cartridge gland, removable without dismantling cylinder, has exclusive Hannifin-developed "Lipseal®-Wiperseal" combination for a truly drip-free rod.

Modern straight thread leak-proof ports for easily positioned fittings are available at no extra cost on hydraulic cylinders.

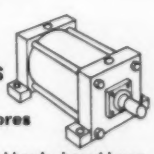
HYDRAULIC CYLINDERS



Two Pressure Ratings

2000 psi (3000 psi non shock), the famous heavy duty Hannifin Series "H" in 1½" to 12" bore.
1000 psi, Series "L", 1" to 8" bore, Hannifin quality in a lighter cylinder. Full compliance JIC Hydraulic Specs.

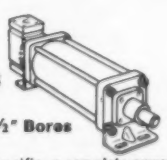
AIR CYLINDERS



1½" to 14" Bores

Series "A"—steel heads, honed brass body for corrosion resistance. Hardened and hard chrome plated piston rod. For all heavy duty air service. Easily modified for water service. Full compliance JIC Pneumatic Specs.

AIR MOTORS



1¾" to 4½" Bores

New from Hannifin, a complete power package combining cylinder and solenoid valve. Only one air line connection. Four mounting styles. Interchangeable mounting dimensions for most applications.

HANNIFIN COMPANY
A DIVISION
525 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

3128-PH

CIRCLE 67 ON READER SERVICE CARD

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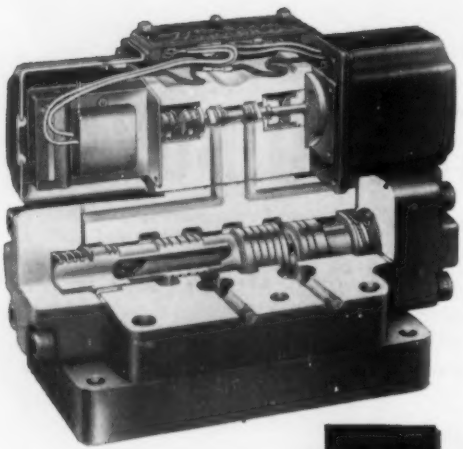
DENISON HydrOILics

Why you get smoother, more efficient directional hydraulic control with compact new **DENISON**...

4-WAY VALVES



Save space, time and cost on exacting directional hydraulic applications. You can apply shockless, positive directional control to any hydraulic circuit—*by specifying Denison 4-Way Valves.* Pilot-operated and solenoid-controlled for systems up to 5000 psi, these service-proved valves offer important features for reliability and design versatility—

Shorter solenoid power stroke permits shorter over-all valve length to speed response. Denison valves deliver fast, rapid-cycle control of flows of 30 gpm at 20 feet-per-second.

Drawn steel solenoid covers are secured to body with internal retaining cords. No bulky chains.

Built-in check valve provides pilot pressure without addition of another valve to the system.

Adjustable pilot chokes assure smooth valving action.

Wide choice of spool types and positioning allows handling an unlimited range of applications.

Denison 4-Way Valves also feature large capacity porting • ample wiring space • interchangeable parts • built to JIC standards.

Contact your nearby Denison hydraulic field specialist for details, or write direct to—

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1194 Dublin Road • Columbus 16, Ohio

WRITE FOR BULLETIN 220– *"Hydraulic Power to 5000 psi". Fully illustrated, gives complete specifications and application data for Denison's full line of hydraulic pumps, motors, valves and controls.*

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

DENISON
HYDRAULIC MULTIPRESS

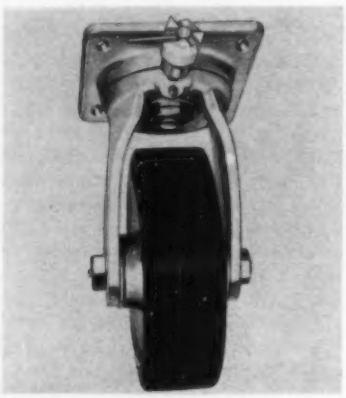
to be same as conventional screws of same size. One unit with ball circle dia (pitch dia) of 0.631 in. has been tested for 45,000 cycles with 500-lb load. Mechanical efficiencies range from 90 to 95%. **Actuator Operation, Saginaw Steering Gear Div, General Motors Corp, Saginaw, Mich.**

Circle 316 on Reader Service Card

Linear actuator . . .

uses dc motor to operate precision ball screw and provides 500 lb over 6-in. stroke. Travel rate is fixed at 10 ipm, but can be adjusted to meet other requirements. Allowable tension or compression load is 2500 lb; temperature range, —65 to 300 F. Operates on 27 to 100 v dc. Measures 14 7/8 x 1 3/4 x 3 3/4 in. and weighs 3 lb, 14 oz. **Globe Industries Inc, 1784 Stanley Ave, Dayton 4, Ohio.**

Circle 317 on Reader Service Card



Caster's swivel lock . . .

operates on spring-loaded pin-stop principle and includes structural nylon cap over which control lever moves easily and positions securely. One through four-position lock models are available. **Albion Industries Inc, Albion, Mich.**

Circle 318 on Reader Service Card

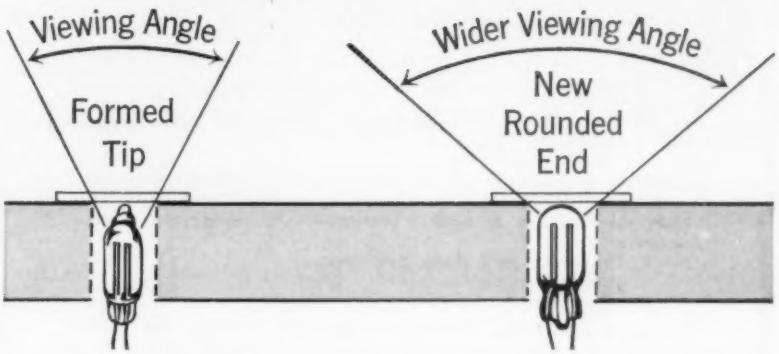
Vinyl-to-metal adhesives . . .

bond films that simulate leather, textiles, wood grains and marble to steel, aluminum and magnesium. Four types include: curing adhesive with heat resistance and hardness that can be controlled by varying curing time and temperatures; thermoplastic adhesive; heat-resistant adhesive for deep draws which allows stress distribution; and thermosetting adhesive. In some cases bonds must be maintained during forming or drawing when portions of the lamination undergo up to 100% elongation. **National Starch & Chemical Corp, 750 3rd Ave, New York 17.**

Circle 319 on Reader Service Card

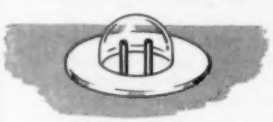
continued on page 70

New round end General Electric glow lamps for better viewing . . . and better looking indicators!



New shape of the Round End Glow Lamp brings its electrodes nearer to the end of the bulb—giving it a much wider viewing angle when flush mounted (see illustration above). And if the Round End Glow Lamp is placed beneath translucent material, the lighted area has a more uniform appearance.

The rounded end of clear-glass gives a distortion-free light when viewed end-on from any angle. Because of its smooth round end, this lamp can be used as a protruding element, thus improving the appearance of the panel.



New General Electric NE-2M (for standard brightness) and NE-2P (for high brightness) Glow Lamps are more thoroughly described in the engineering data sheet, #3-9289. For your free copy, write: General Electric Company, Miniature Lamp Department M-112, Nela Park, Cleveland 12, Ohio.

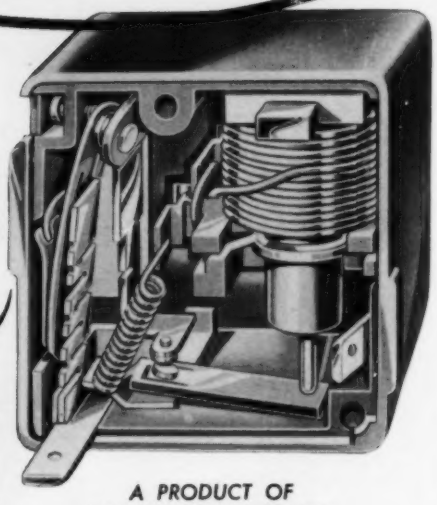
Progress Is Our Most Important Product

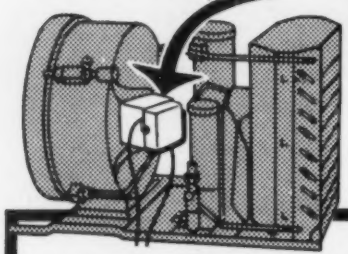
GENERAL ELECTRIC

Chace
THERMOSTATIC BIMETAL

ACTUATES ANOTHER PRECISION PRODUCT...

Ranco®
COMBINATION STARTING RELAY AND OVERLOAD PROTECTOR





A PRODUCT OF
RANCO INCORPORATED
COLUMBUS 1, OHIO

Flexibility of design in this fine Ranco product — Ranco Type H60 combination motor starting relay and overload protector — produces three results of utmost importance to refrigerator manufacturers:

1. **Provides better motor protection.**
2. **Allows increased compressor capacity.**
3. **Assures dependable starting.**

The Ranco H60 plugs directly onto the three terminal pin cluster of hermetic refrigerator compressors. It can be provided with a variety of terminals and covers for both screw type and quick connect line terminals. A horsepower range from 1/3 HP, 115 Volts to 1/12 HP, 230 Volts is possible.

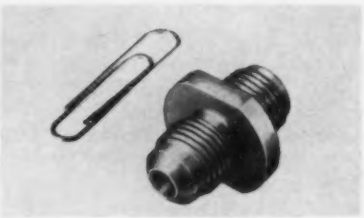
The overload protector here is of the "Inherent" type and decides how much load the motor should accept (cool motor, high current; warm motor, low current). The "deciding" in the Ranco Combination Starting Relay and Overload Protector is done by dependable Chace Thermostatic Bimetal.

The flexibility of design and wide horsepower range of this Ranco product are provided through the use of several bimetal shapes and more than two dozen different types and thicknesses of Chace Thermostatic Bimetal. Ranco uses one word to describe Chace Thermostatic Bimetal: "dependable." This has been Chace's specialty for more than a third of a century . . . dependable, *precision* thermostatic bimetal. Hundreds of manufacturers depend on Chace Thermostatic Bimetal . . . they know their good names are safe on the outside with Chace Thermostatic Bimetal on the inside of their products.

SEND NOW FOR OUR NEW "INFORMATION BOOKLET!" It contains many well illustrated pages of valuable design data and examples of successful applications of bimetal. More than 40 types of Chace Thermostatic Bimetal are available in coils, strips and completely fabricated elements of your design.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1602 BEARD AVE., DETROIT 9, MICH.



Miniature in-line checkvalve

permits free fluid flow in one direction, and checks reverse flow. One end fits into a valve body and opposite end connects with a tube. Designed for 1000-psi operating pressures, valve cracks at 5 to 8 oz-in. and has 1-gpm flow capacity. Handles any fluid compatible with materials in —65 to 450-F range. **Fluid Regulators Corp, 313 Gillette St, Painesville, Ohio.**

Circle 320 on Reader Service Card

Thermoelectric generators . . .

in ratings of 5, 10, 50 and 100 w, are completely static and suitable for cathodic protection of pipelines, valve control and for powering microwave relay equipment. Can be designed to combine any type of fuel and cooling medium. Gasoline, propane and natural gas are typical fuels, while forced air, water or natural convection are typical coolants. Operate at core temperatures between 572 and 1112 F, depending on application and type of fuel used. Basic outputs are: 5 w (1.7 v at 4 amp); 10 w (3.4 v at 4 amp); 50 w (4.7 v at 13 amp); and 100 w (9.4 v at 13 amp). **Westinghouse Electric Corp, Box 2278, Pittsburgh 30.**

Circle 321 on Reader Service Card

Mylar jackets insulate . . .

electrical and electronic parts against electrical effects and/or corrosion. Eliminate costly handwrapping with pressure-sensitive insulation. Jackets are made of Mylar film laminated to polyethelene which permits them to be shrunk or expanded without breaking down material structure. Polyethelene flows with Mylar to create firm bond without crystaline bonding agent. Available in most shapes and sizes for hermetic sealing on production lines or automated assembly operations. **Precision Paper Tube Co, Dept PE-1, 2035 W Charleston St, Chicago 47.**

Circle 322 on Reader Service Card

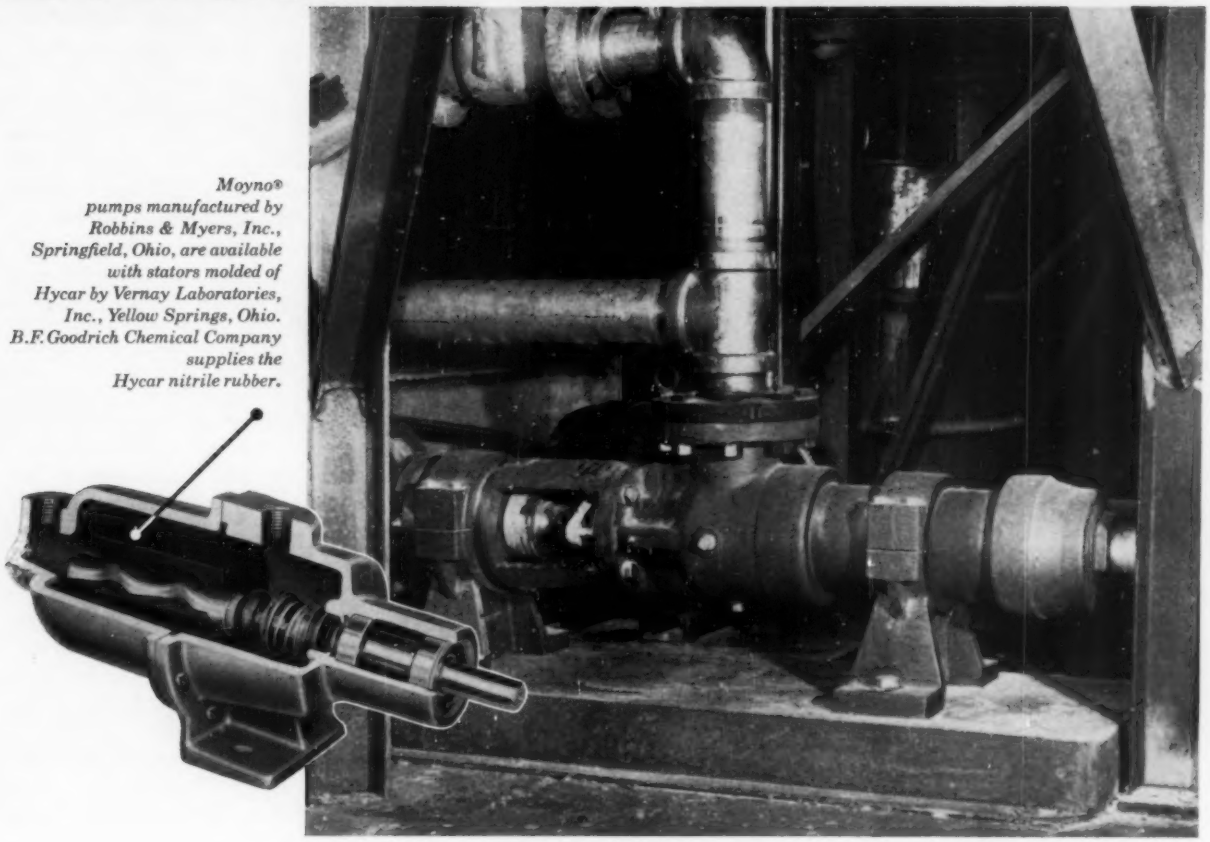
Heavy-duty dispenser . . .

delivers full flow of oil or other liquids when valve is opened and stops feeding when valve is closed. Flow is by gravity through ¼-in.-OD nylon or metal tubing connected to single or multiple-feed valves for adjusting rate of feed. Either the

continued on page 74

Another new development using

B.F.Goodrich Chemical *raw materials*



Moyno® pumps manufactured by Robbins & Myers, Inc., Springfield, Ohio, are available with stators molded of Hycar by Vernay Laboratories, Inc., Yellow Springs, Ohio. B.F.Goodrich Chemical Company supplies the Hycar nitrile rubber.

STATORS OF HYCAR RUBBER
help pumps handle corrosive jobs

The manufacturer of these pumps says they handle "anything that flows through piping." When the going gets unusually corrosive or abrasive, stators made of Hycar nitrile rubber are used.

The Hycar stators are made in varying hardnesses—rigid for handling some materials, flexible for others. Any corrosive or abrasive material may call for Hycar stators; this pump manufacturer particularly recommends it for petroleum solvents and oils, vegetable oils, alcohols, all salt solutions, mild acids and corrosive liquids.

Hycar gives long-term service in an application like this because of its resistance to chemicals and corrosion that would destroy ordinary rubber. Hycar can be accurately molded into the complex double internal helical design of this pump's stator.

Here's another example of the way that Hycar nitrile rubber helps products find new applications, or helps develop new products. For information, write Dept. MJ-1, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Hycar
REG. U.S. PAT. OFF.
Rubber and Latex

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

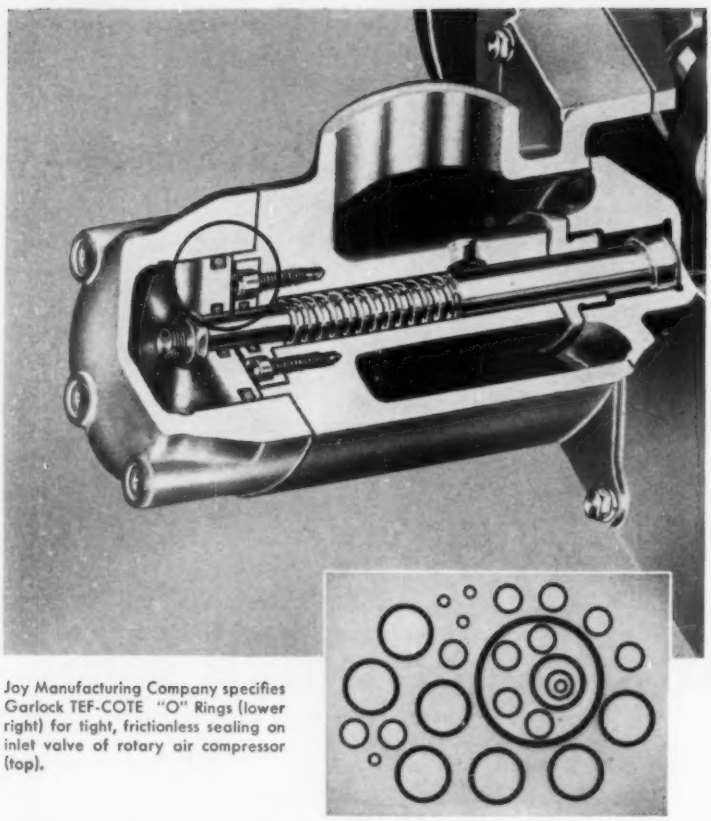
B.F.Goodrich

GEON vinyls • HYCAR rubber and latex • GOOD-RITE chemicals and plasticizers

CIRCLE 71 ON READER SERVICE CARD

ENGINEERED TEFLON PRODUCTS

for Hydraulic, Pneumatic Service



Joy Manufacturing Company specifies Garlock TEF-COTE "O" Rings (lower right) for tight, frictionless sealing on inlet valve of rotary air compressor (top).

Garlock TEF-COTE "O" Rings stop air leakage—without slip stick and adhesion —on Joy portable compressors.

During exhaustive tests of 500,000 cycles at a 1″ stroke, TEF-COTE "O" Rings proved completely satisfactory for operation on Joy two-stage rotary portable air compressors supplied to the Corps of Engineers. As plunger seals on the inlet valve, the rings seal pressures to 40 p.s.i., temperatures from +90°F to +120°F on a rotary shaft moving at 30 cycles per hour.

To minimize cylinder breakaway friction, chattering or freezing, do as the Joy Manufacturing Company has done. Investigate the possibility of Garlock TEF-COTE "O" Rings on hydraulic and pneumatic valves and cylinders, and valve stems. TEF-COTE "O" Rings—solid rubber, coated with Teflon†—offer a fine combination of low breakaway and low running friction. Garlock also offers "O" Ring Packings of solid Teflon for exceptional antifriction sealing at temperatures from −100°F to +500°F. Where unidirectional pressures are encountered, specify Garlock slotted "O" rings of Teflon—they are designed for simple installation into standard AN grooves.

When you design fluid power equipment, consider using Garlock "O" Ring Packings. They are available in many sizes and materials—nitrile, butyl, silicone, and Viton† rubber and Teflon to meet your needs. For application recommendations, consult your local Garlock representative. He is backed by years and years of experience in the design, manufacture and application of packings and seals of all types. Call him at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalogs AD-148 and AD-157. Garlock Inc., Palmyra, N. Y.

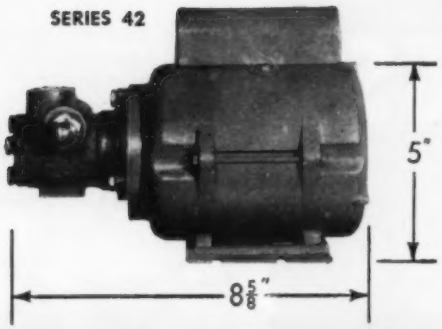
GARLOCK

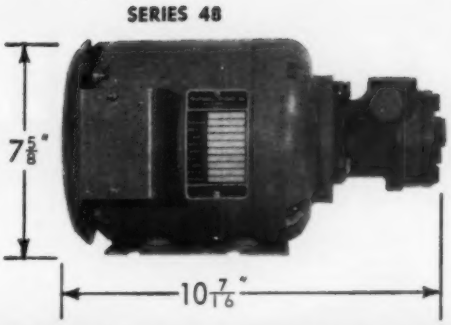
Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastics Products.

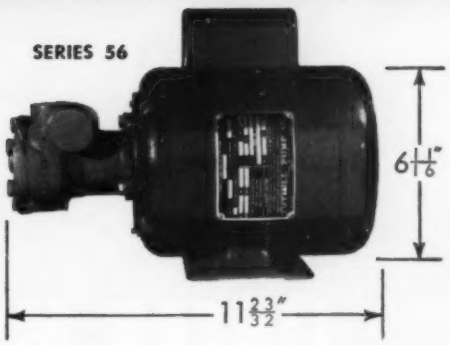
†DuPont Trademark





SAVE SPACE...WEIGHT...MONEY

with TUTHILL close-coupled pump and motor combinations



Tuthill close-coupled pumps and motor combinations are especially designed for applications where space is at a premium. Their compactness simplifies assembly operations and lowers production costs. Elimination of couplings, bases and adapters results in significant savings . . . and reduced weight means lower shipping costs.

Tuthill offers a complete selection of units with capacities up to 50 GPM for pressures to 500 PSI. A wide variety of special options is also available. Three standard units are pictured above.

Immediately available from stock

The series 42 units measure only 5"x8 5/8". Their total enclosed ballbearing motors are normally supplied with ratings from 1/12 to 1/6 HP while the pump units have capacities of 20 to 45 GPH at 200 PSI.

Series 48 units, measuring 7 5/8"x10 7/16", are normally supplied with totally enclosed, fan-cooled motors of either split phase, capacitor, or 3 phase construction . . . with ratings from 1/4 to 1/2 HP. They can be supplied with pumps with capacities from 20 GPH to 360 GPH at 200 PSI.

Series 56 units measure 6 11/16"x11 23/32", and are offered in a complete range of motors varying from 1/4 to 1 HP. These can be coupled with pumps with capacities from 20 to 360 GPH at 200 PSI.

Although motors are normally furnished for 1725 RPM they are also available for 3450 and 1140 RPM. Explosion proof construction and double shaft extensions on motors are also furnished in series 48 & 56. Built-in relief valves are optional on all five pump sizes.

Special construction for OEM applications

The units shown plus others in Tuthill's line are immediately available without any quantity restrictions whatsoever.

For those original equipment applications involving substantial quantities, Tuthill's engineers can design and build a POWERMITE . . . an exclusive Tuthill design in which pump and motor are combined in one unit which takes up no more space and weighs no more than a standard electric motor. As an example of the compactness possible a Tuthill POWERMITE now being supplied for a hydraulic application measures only 4 3/4"x8 1/6", yet has a capacity of 16 GPH at 350 PSI.

Tuthill's field engineers will be happy to provide details on the complete Tuthill close-coupled line and its application to your particular problem. If you are trying to fit a pump and a motor into a tight space you should talk to them soon. Call today.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 GPM; for pressure to 300 PSI; speeds to 3600 RPM.

PUMPS FOR YOUR PURPOSE

TUTHILL PUMP COMPANY

963 East 95th Street Chicago 19, Ill.

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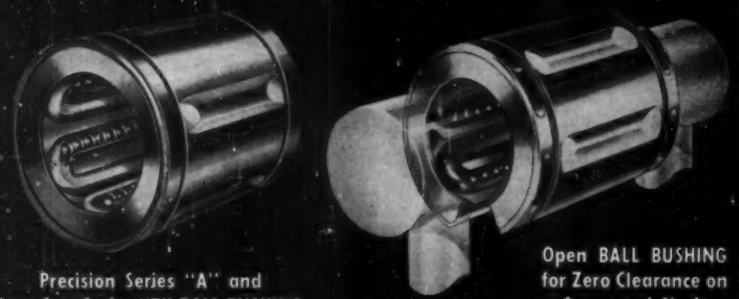
NOW! *Adjustable Diameter and Open*
THOMSON
BALL BUSHINGS

Adjustable Diameter
BALL BUSHING
for Zero Clearance

The BALL Bearing
for *all* your **LINEAR MOTIONS**



Precision Series "A" and
Low Cost Series "B" BALL BUSHING

Open BALL BUSHING
for Zero Clearance on
Supported Shafts

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSHINGS on *guide rods, reciprocating shafts, push-pull actions,* or for support of *any mechanism that is moved or shifted in a straight line.*

Improve your product! Up-date your design and performance with Thomson BALL BUSHINGS!

LOW FRICTION • ZERO SHAKE OR PLAY
ELIMINATE BINDING AND CHATTER
SOLVE SLIDING LUBRICATION PROBLEMS
LONG LIFE • LASTING ALIGNMENT

The various types cover a shaft diameter range of ⅛" to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.

THOMSON INDUSTRIES, Inc.
Dept. H, MANHASSET, NEW YORK

Also Manufacturers of NYLINED Bearings . . . Sleeve Bearings
of DuPont Nylon, and 60 CASE . . . Hardened and Ground Steel Shafting

manually controlled or electric solenoid-operated types are available in five sizes: 10 oz, 1 pt, 1 qt, 2½ qt and 1 gal. On solenoids, 115 or 230 v, 60 c is standard. Reservoirs have Pyrex glass or shatter-proof Lucite cylinders. **Trico Fuse Mfg Co, 2948 N 5th St, Milwaukee 12.**

Circle 323 on Reader Service Card

Tube reducer . . .

with separate O-ring seal and grip, has internal bushing, which substantially shortens over-all length. Split ring grips and locks tube. The higher the pressure, the stronger the split ring grips and the tighter the O-ring seals. Available from stock in 42 sizes from ⅜ x ¼ in. to 2 x 1½ in. **Lenz Co, 3301 Klepinger Rd, Dayton 1, Ohio.**

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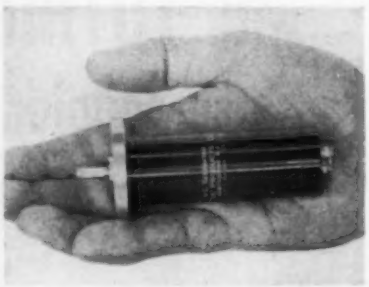
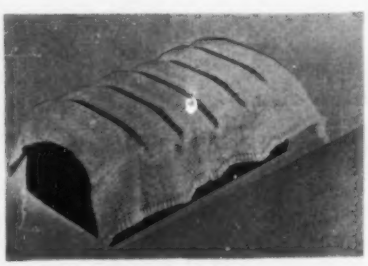


45-v, 1000-rpm tachometers

have longer armatures which increase voltage output while keeping inertia at a minimum. Suitable for applications that require min size and weight. Frame measures 1⅛-in. dia, and over-all body, approx 3½ in. long. Outer-shaft bearing has neoprene seal to prevent contaminants from entering. From stock at $57.50 each. **Servo-Tek Products Co, 1086 Goffle Rd, Hawthorne, NJ.**

Circle 325 on Reader Service Card



Fiberglass cloth . . .

for reinforcing plastics, will form into and retain its position in deeply recessed, sharp-contour surfaces despite its 0.0283-in. thickness. Said to allow faster laminating, less layers at lower cost and less

continued on page 76

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New

ROTO-MISSION
TRADE MARK

PATENTED

Most versatile transmission ever developed!

ONLY ROTO-MISSION GIVES YOU ALL THESE FEATURES

- Concentric configuration
- Minimum size for a specified torque
- Reduction ratios up to 270:1
- Optional torque capacities for each reduction ratio
- Torques up to 21,850 lb.-ft.
- Requires neither driving pulley nor coupling
- Casehardened helical gears—ground after hardening for perfect engagement
- Reversible
- Progressive overload capacity to the extent that no breakage of gears can result even from the severest abuse
- *Ability to engage or disengage driving action —mechanically, pneumatically, hydraulically or electrically
- *Ability to provide load releasing, load limiting or overload alarm
- *Ability to provide 2-speed operation

*Standardized accessories to provide these features are available for all sizes of Roto-Mission from stock. This results in a single responsibility for installation performance.

This new rotary transmission design combines a wide range of reduction ratios, high torque capacities, and excellent space-saving characteristics to give you more application versatility than ever before possible. It is designed to be concentrically mounted on a machine drive shaft in place of the drive pulley and operate this shaft at a reduced speed from that of the driving motor. For maximum compactness and convenience, all its parts are inside the casing.

The standard accessories available for each model of Roto-Mission add even greater versatility. Through them you have systems—from a single source—capable of control functions that previously required a number of unmatched units from several suppliers.

Because of its versatility and sound engineering, Roto-Mission permits you to solve design problems far beyond the range of other transmissions —may even permit incorporation of features in your machines that have not previously been possible. For complete information on this new product—how it operates and how it can help you —write today for Catalog IR-60.

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Engineered Equipment for Aircraft and Industry

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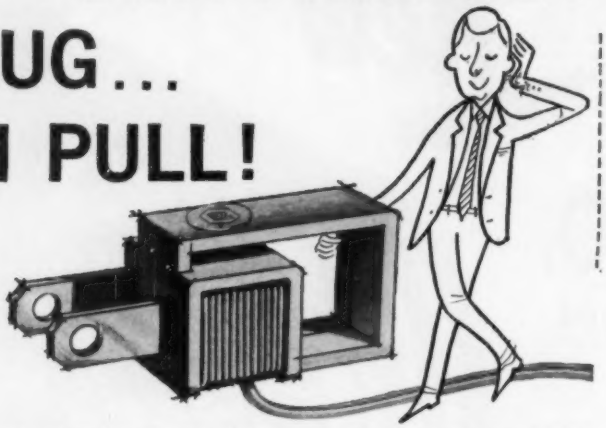
GIVE YOUR PRODUCT A PLUG... WITH PULL!



This unusual cord set — introduced and patented by Miller Electric — is specified as the **finishing touch** by America's best known manufacturers.

Imaginatively designed to simplify and speed removal from any outlet, the trim, modern **Finger-Pull Plug** overcomes "wire yanking" habits that cause annoying and dangerous failures in ordinary plugs.

Cord can be hanked through loop. Dealers like to demonstrate it. Customers like to use it. You'll like its unlimited color co-ordination possibilities and the way it can effectively display your trademark. Styles available for light and heavy duty and 3-wire applications.

You get even **more** of a competitive advantage from cost-conscious Miller Electric's complete engineering service for problem applications, extremely efficient production and respect for your production schedules.

Whether from the industry's broadest line of stock cord set components or custom-engineered, Miller gives your product a "plug".

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MILLER ELECTRIC CO.

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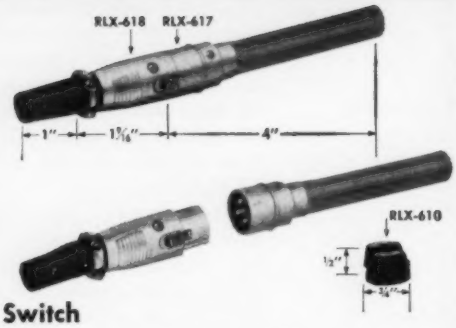
POST ELECTRONIC PRODUCTS



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MH-2-P Magnetic Switch

A new and improved sensing device . . . neatly contained in an epoxy resin shell. The MH-2-P is ideal for industrial applications and is easier to mount in areas of limited access. A quick disconnect Cannon connector eliminates elbow type construction.

The new epoxy resin housing results in less magnetic flux and increased sensitivity. As a consequence, smaller magnets can be used and manufacturer reports a minimum magnetic field transient time of only 8 milliseconds is needed to activate the switch. Operating life is in excess of one billion operations.

Write For Bulletin MH-2-P

Decitron

POST ELECTRONIC PRODUCTS

Division of Reid Brothers Company, Inc.

12 LOTHROP ST. / BEVERLY, MASS.

interlaminar residual stresses in sharp-contour laminates. **Rezolin Inc, 1651 18th St, Santa Monica, Calif.**

Circle 326 on Reader Service Card

Oil monitor . . .

on two-stage compressor, has switch with 25% greater capacity than previous model and molded plastic switch cover that eliminates arching between terminals and cover. Monitor operates through positive-acting centrifugal unloader and does not rely upon oil pressure or mechanical pressure linkage. Float and stem device rides in flow bowl, and when oil level drops below normal level, device moves downward out of path of piston rod which trips switch. **Champion Pneumatic Machinery Co., Princeton, Ill.**

Circle 327 on Reader Service Card

Triangular templet . . .

contains selection of most commonly used drafting symbols, including standard sizes of bolts, nuts and screws. Device measures 9⅛ in. and includes 225 holes. Priced at $6.95 each. **Ray Martin Enterprises, 202 Bertrand Rd, Niles, Mich.**

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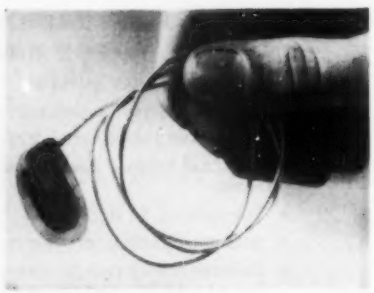

Pressure transducer . . .

measures only 0.035 in. thick and 1 x 1 in. over-all. Sensitive area is 1 cm². Responds only to normal forces and is hermetically sealed for use in pressure range from 15 in. Hg vacuum to 100 psi. Changes capacitance with pressure and can be used with bridge or resonant circuits. Priced at $40 each; delivery in 2 wk. **Spitz Laboratories Inc, Yorklyn, Del.**

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Printed-circuit kit . . .

contains enough material to make three printed wiring boards. Includes copper-clad board, liquid chemical etch, etch-resistant terminal pads and tape, and plastic etchant tray. From stock at $5 per kit. **Advanced Designs Inc, 914 Lullaby Lane South, Vienna, Va.**

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ANNOUNCING A NEW IDEA IN BRONZE BUSHED BEARINGS ...A PRECISION LINER THAT IS REPLACEABLE ON THE JOB!

1. Precision bronze liner, replaceable without removing shaft or bearing base.
2. Rugged semisteel housing to withstand heavy shock loads. (Ductile iron or steel to order.)
3. Bottom of base machined for perfect alignment; close tolerance held to center of bore.
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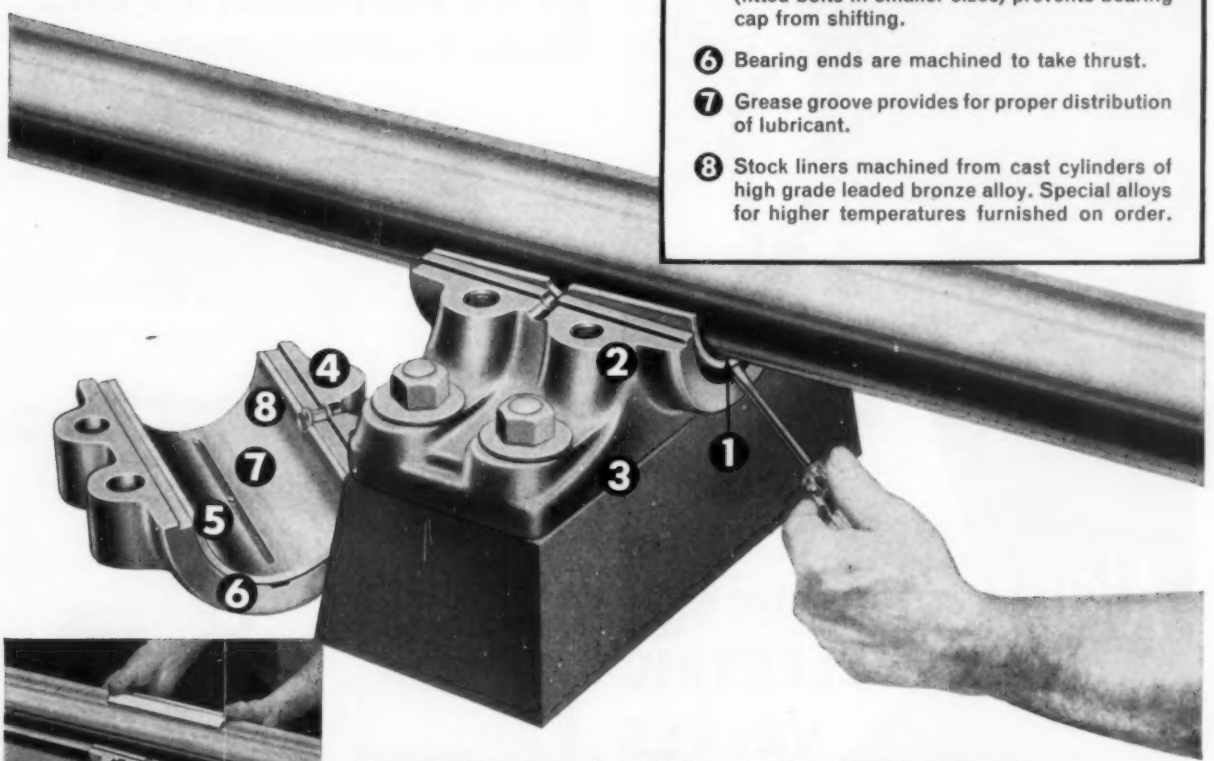
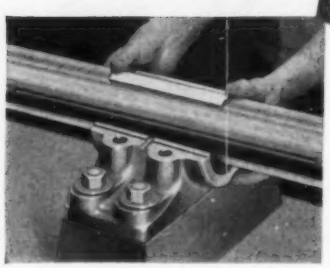
5. Tongue-and-groove joint in 4-bolt base sizes (fitted bolts in smaller sizes) prevents bearing cap from shifting.
6. Bearing ends are machined to take thrust.
7. Grease groove provides for proper distribution of lubricant.
8. Stock liners machined from cast cylinders of high grade leaded bronze alloy. Special alloys for higher temperatures furnished on order.





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CALL THE TRANSMISSIONEER — your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the yellow pages under "Power Transmission Machinery."

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Model 250-4E2
1/4" 4-Way, Momentary Contact
Air flow . . . 80.04 cfm at 100 psi inrush current . . . 0.165 amp at 115 v. Stabilized current ...0.136 amp at 115 v. Pressure range . . 30 to 125 psi Size . . . 4-5/16" high; 4-1/4" wide; 2-3/8" thick. (Model 250-4E1 maintained contact valve, same dimensions).

New! Humphrey ELECTRIC VALVES

Now Humphrey offers you completely tested new BIG CAPACITY electric valves . . . that provide positive dead seal closing . . . that have built-in quick exhaust . . . that require no lubrication. New type solenoids with continuous duty coils, Expoxie Sealed. Low current consumption requires no relays, Armature stroke of .022" speeds up valve actuation and eliminates hammering. Choice of 2-way, 3-way and 4-way . . . 1/4" and 1/2" . . . maintained contact or momentary contact. All miniaturized to help you design maximum valve capacity into minimum space.

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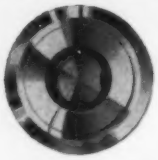
NEW



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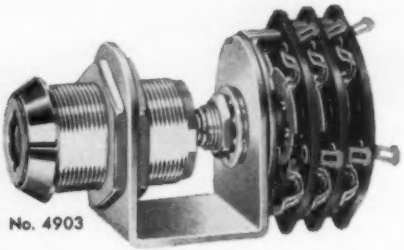
CHICAGO ACE®
PIN TUMBLER LOCKS



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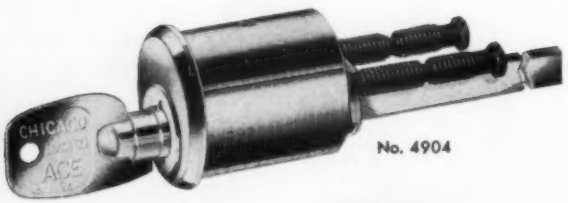

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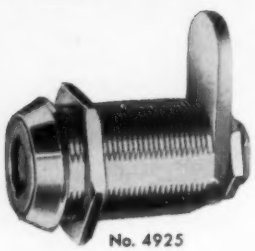

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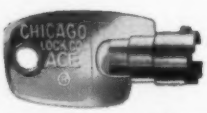
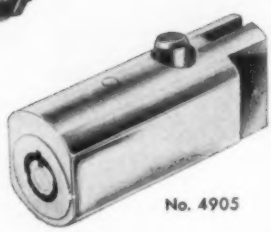


Hardened Steel ACE Key



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Here is the only line of locks listed by Underwriters' Laboratories. The unique ACE Locks provide the maximum in mechanical security. Over 80,000 keying combinations are possible so that you may have your own factory-registered tumbler set-up. For technical details on models available for various applications, write for Switch Lock Bulletin UB 501.

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DESIGN LITERATURE

Development of Beryllium Castings

CROSSLEY, METCALFE AND GRAFT, Armour Research Foundation of Illinois Institute of Technology. PB 161754 (WADC Technical Report 59-500). Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 92 pp. $2.50.

Cast beryllium is brittle because of its coarse columnar structure. To get around this brittleness, the primary metal has been made exclusively by metal-powder processes which are expensive. However, for cast parts, the problem could not be circumvented—the cast structure had to be refined before beryllium castings could be made practical. The basic problem of grain refinement was studied from several approaches: melting variables in consumable-arc melting; innoculation; magnetic stirring of the molten metal and vibrating of the metal during solidification. None of the methods produced a sufficient grain refinement to make beryllium castings practical, but some showed enough promise to be investigated further.

Mathematical Snapshots

H STEINHAUS, Oxford University Press, NYC. 5½" x 8½", 328 pp. $6.75.

Topics in this new edition range from problems in chess to the pursuit of ships, the fair division of a cake, and the tying of knots. Each topic will interest many readers, and the simple text and clear illustrations make it a book easily followed by anyone with a knowledge of algebra. However, the book has the disconcerting habit of flitting too quickly from topic to topic and leaving the reader with the wish that more time had been spent on each point.

Statics and Strength of Materials

MILTON G BASSIN and STANLEY M BRODSKY McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 9¼" x 6¼". 354 pp. $7.

Based on the well-known standard work, "Practical Mechanics and Strength of Materials" by Leigh and Mangold, this new text is designed to keep step with modern engineering practice.

The first section of this book covers topics in mechanics: resultants and equilibrant of forces, moments and forces, static and kinetic friction. The second section goes into strength of materials: simple stresses; properties of materials; riveted and welded joints and thin-wall cylinders; center of gravity, centroids, and moment of inertia; beams—shear forces and bending moments; beams—design; torsion, shafts, shaft couplings, and keys; combined stresses, columns, and indeterminate beams.

The text material is supported by numerous solutions of sample problems, illustrations and tables.

end

Other Books of Interest

Transistor Manual

General Electric Co, Semiconductor Products Dept, Kelley Building, Liverpool, NY. 6 x 8¾, 329 pp. $1.

Fundamental Engineering-drawing Problems

C J Vierck, R. I. Hang. McGraw-Hill Book Co Inc, 330 W 42nd St, NY 36. Kit, 9¾ x 13, $4.25.

For use in conjunction with the authors' textbook on this subject in teaching of elementary engineering drawing.

Dynamics of a System of Rigid Bodies—Advanced and Elementary

E J Routh. Dover Publications Inc, 180 Varick St, N Y 14. 5½ x 8, elementary, 443 pp; advanced, 484 pp. $2.35 each.

Unabridged paperback edition of the author's last revised editions, dated 1905.

Correlation of the Buckling Strength of Pressurized Cylinders in Compresion or Bending with Structural Parameters

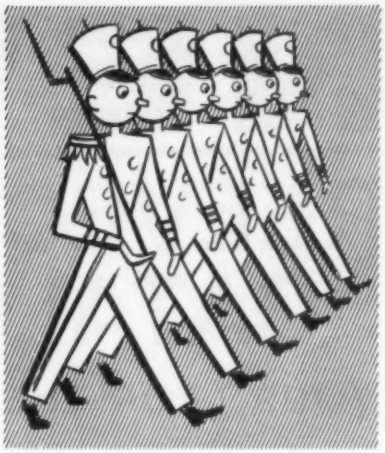
NASA TN D-526. J P Peterson. National Aeronautics and Space Administration, Washington, DC. 8 x 10¼, 21 pp. 75¢.

ABSTRACTS FROM THE LITERATURE

Performance of Engine Lubricants

This paper describes one of the engine tests which is being used to define minimum acceptable performance, in current passenger-car engines, of oils designated for MS service. This test is commonly known as Sequences I, II, and III of the G-IV Test Sequences. The paper discusses the test development, describes the engine operating conditions, points out some

continued on page 81



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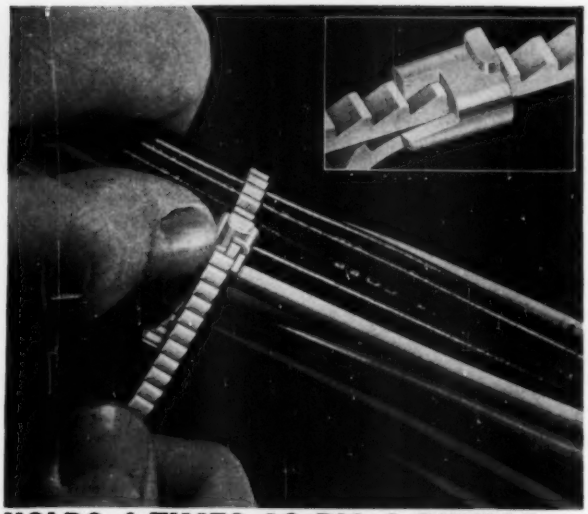

HOLDS 4 TIMES AS BIG A BUNDLE— HOLDS AT 50 G'S

Genuine Bund-L-Tite* nylon straps are twice as long and fully 10 times as strong as any other bundle-tying strap made. This means that you can secure larger bundles at greater stresses. Bund-L-Tite is fast and simple, too: just pull the self-locking strap around the wires. No tying, no knots, no hitches to come loose. Light-weight DuPont zytel meets MIL-P-17091. ⅛" size holds 40 lbs. tension; 3/16", 175 lbs.; ¼", 325 lbs. IMITATED BUT NOT DUPLICATED. Write for free literature.

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4315 Sepulveda Blvd., Culver City, California

Manufacturer of Cab-L-Tite clamps.

*Trade Mark

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- ☐ Measuring roughness of parts that are
  - ☐ Extra-smooth?
  - ☐ Short or narrow?
  - ☐ Concave or convex?
  - ☐ Inside small ID's?
  - ☐ Remotely located?
  - ☐ Of critical importance?
- ☐ Measuring height and width of waves, bows, steps and other widely-spaced irregularities?
- ☐ Measuring individual pits, flaws, scratches?
- ☐ Measuring waviness around surfaces of rotation?
- ☐ Other:_____

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CIRCLE 208 ON READER SERVICE CARD

of the important variables, shows the correlation with service, and indicates some of the test limitations.

"An Engine Test for Predicting the Performance of Engine Lubricants in Most Severe Passenger-car Service," Paul A. Bennett, George K. Malone, Chester K. Murphy, Fuels and Lubricants Department, General Motors Research Laboratories, SAE Preprint #261A, Dec '60, SAE, 485 Lexington Ave, New York 17.

Precise-frequency Power Generation

The system described generates precise-frequency power from an unregulated shaft through use of a high-frequency variable-speed brushless generator, a semiconductor frequency changer, an output filter, and a voltage and frequency regulator.

"Precise-Frequency Power Generation from an Unregulated Shaft," K. M. Chirgwin and L. J. Stratton, Jack & Heintz Inc, Electrical Engineering, Dec '60, Cleveland.

Design Problems in Microminiaturization

This discusses some of the methods and techniques that have resulted in size reductions of 100 to 1000 times during the past decade and examines some of the approaches that promise a 10 to 1000 times additional size reduction in the next decade.

"Design Problems in Miniaturization and Microminiaturization," J. J. Staller and W. E. Scott, Sylvania Electric Products Inc, Needham, Mass. Paper No 3.2 published in NEREM Record, Nov '60, Institute of Radio Engineers (Boston section), Boston.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

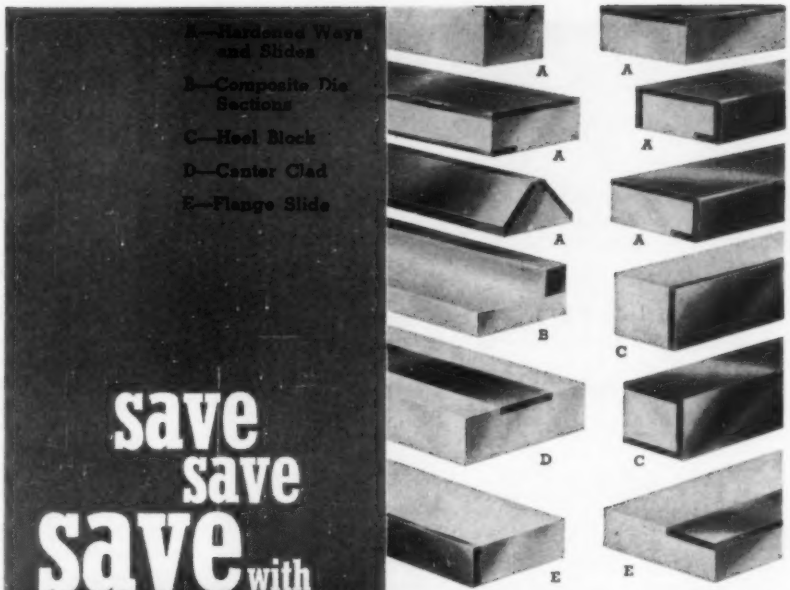
SELF-OILING BRONZE BEARINGS—Brochure S-60, 18 pp. Lists 1066 standard sleeve-, flange- and thrust-bearing sizes, as well as cored-, bar-, and plate-stock, disks and strips made to dimensions shown. Discusses tolerances, typical properties, installation and machining. Curves depict press-fit values, ID close-in and bearing clearance. Ampex Div, Chrysler Corp, Box 2718, Detroit 31.

Circle 350 on Reader Service Card

FLEXIBLE TUBING—Brochure 30-39, 4 pp. Tabulates characteristics, construction and standard sizes of seven types for ventilation, fume-removal and materials-handling systems. Flexible Tubing Corp, Guilford 2, Conn.

Circle 351 on Reader Service Card

continued on page 83



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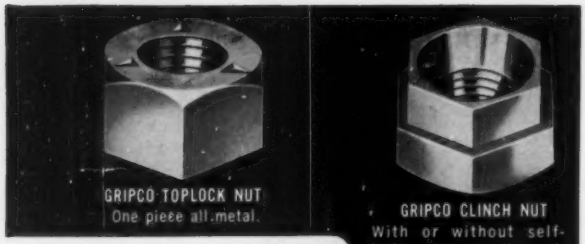
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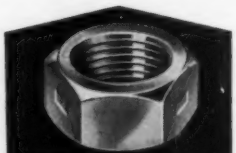

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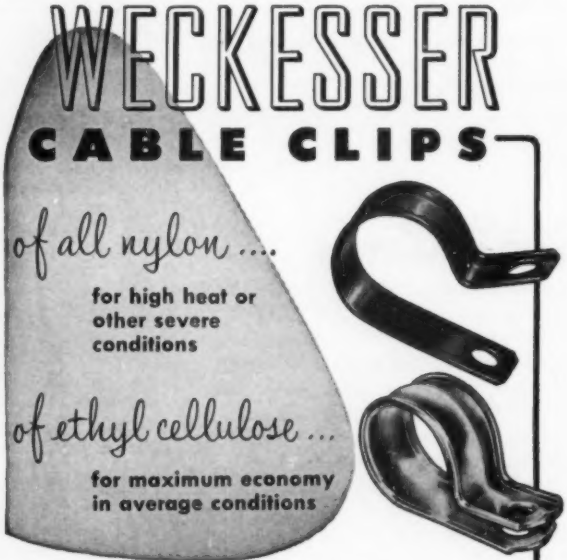

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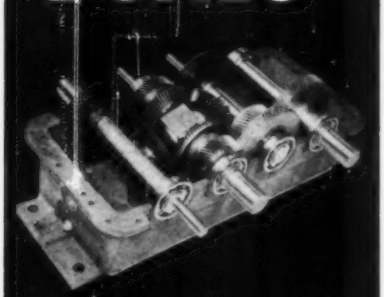

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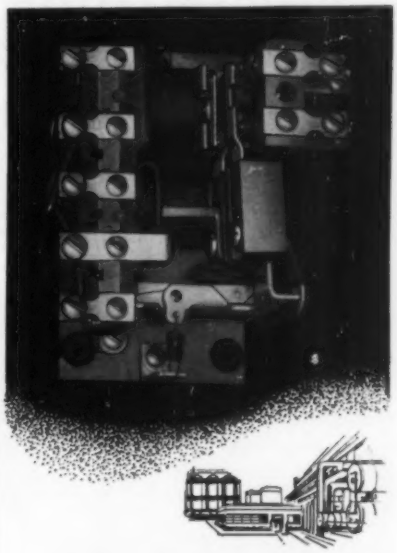

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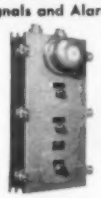

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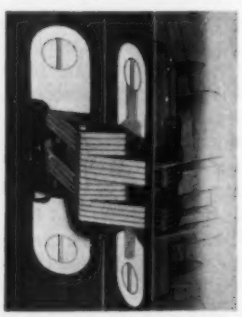

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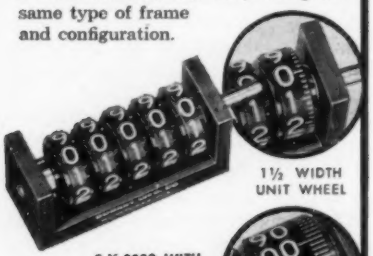

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SPIRAL BEVEL GEARS—Catalog, 6 pp. tabulates specifications of standard sizes with ratios of 1:1, 2:1, 3:1, 3:2, and 4:3. Outlines determination of velocity factor by peripheral speed. Perkins Machine & Gear Co, West Springfield, Mass.

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MINIATURE FILTER ASSEMBLY—Bulletin 600, 4 pp. Discusses construction, performance and applications for 1¼-in. sq in-line filter. Includes specifications and engineering drawings. Dumont Engineering Corp, 1401 Freeman Ave, Long Beach, Calif.

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SCREWED-END PLUG VALVES—Bulletin D-1, 4 pp. Tabulates dimensions of

continued on page 86

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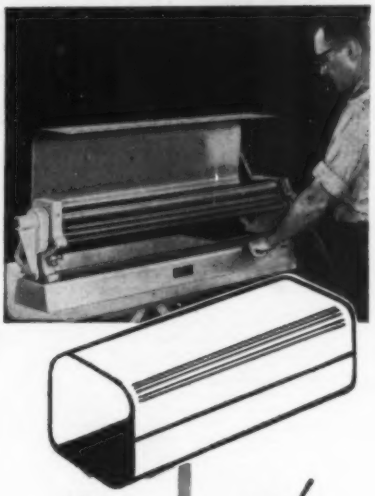

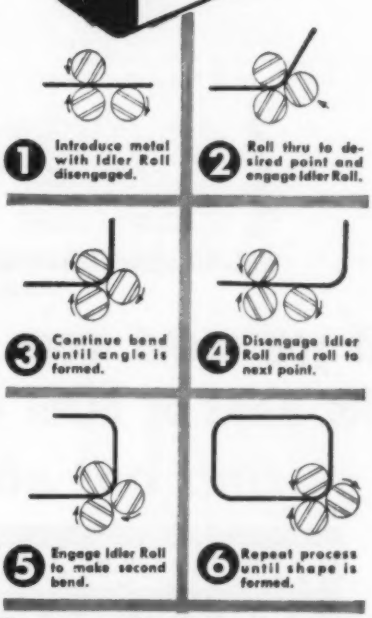
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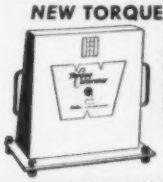

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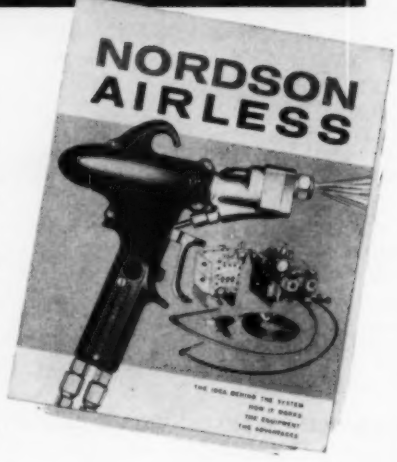

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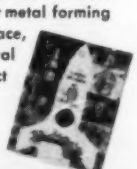

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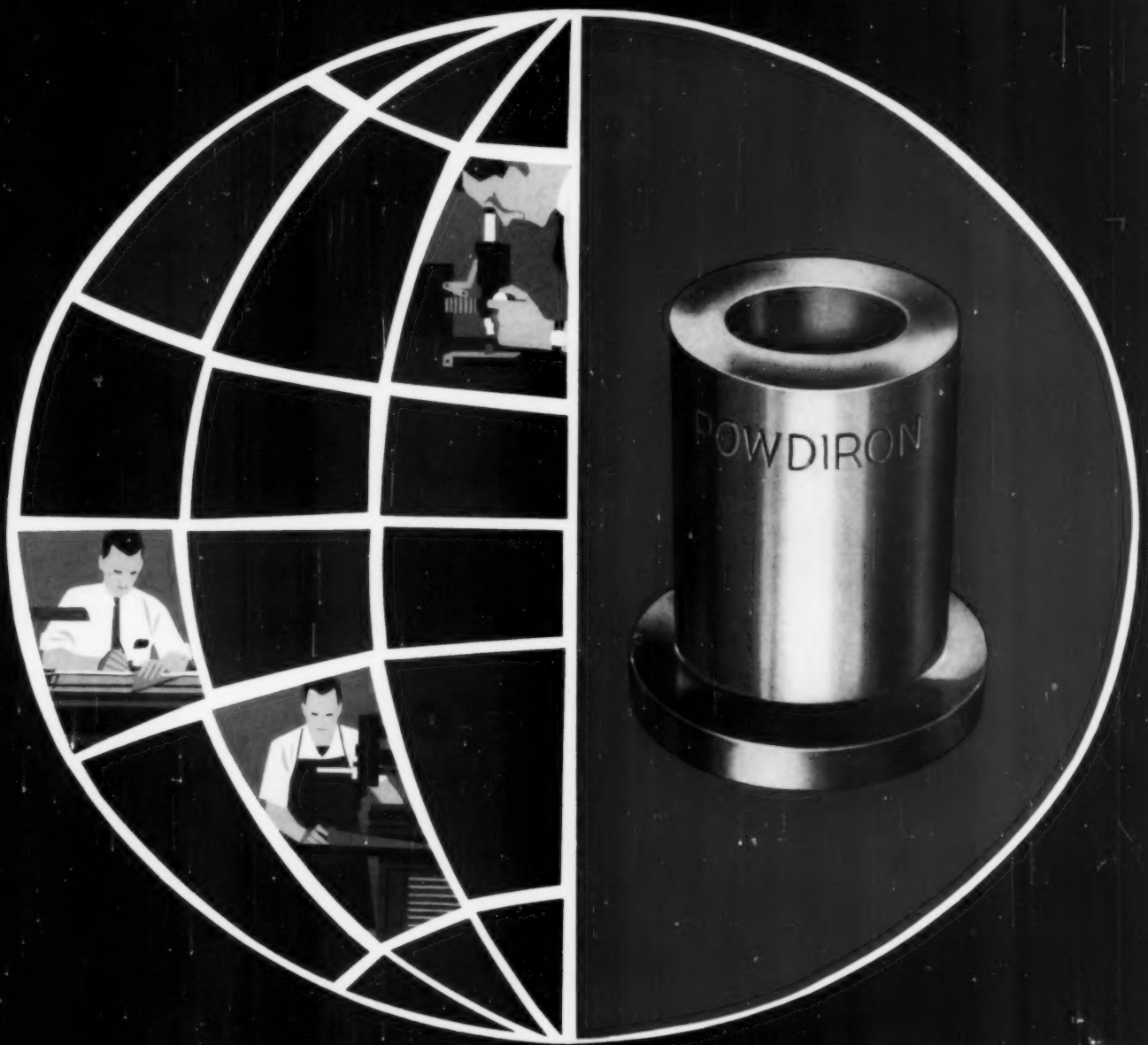

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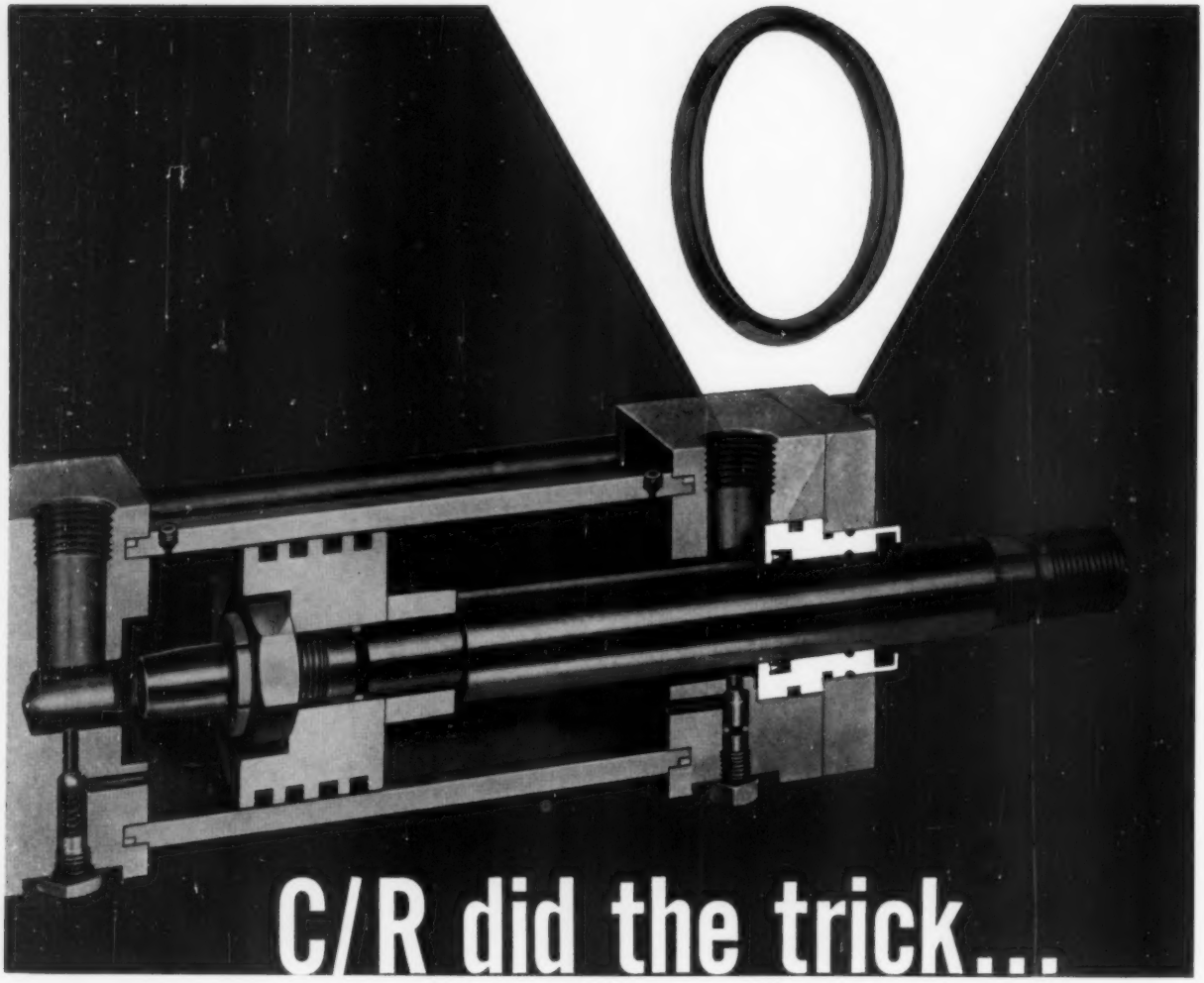

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